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22 July 2004

From: Commanding Officer, Engineering Field Activity West, Naval Facilities Engineering Command

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Subj: DRAFT SAMPLING AND ANALYLSIS PLAN ADDITIONAL GROUNDWATER INVESTIGATION AT TIDAL AREAL LANDFILL, SITE 1, NAVAL WEAPONS STATION SEAL BEACH, DETACHMENT CONCORD, CONCORD, CALIFORNIA

Encl: (1) Draft Sampling and Analysis Plan (Field Sampling Plan/Quality Assurance Project Plan) Additional Groundwater Investigation at Tidal Area Landfill, Site 1, Naval Weapons Station Seal Beach, Detachment Concord, Concord, CA (22 July 2004)

1. In accordance with Sections 10.2 (a) and 10.7 (b) of the Federal Facility Agreement (FFA), enclosures (1) and (2) are provided for your review and comment. Enclosure (1) is a primary document and in accordance with Section 10.7 (b) of the FFA, your review is to be completed within sixty (60) calendar days following receipt of the document. Therefore, Agency review comments are requested by Tuesday, 21 September 2004.

2. If there are any questions regarding the enclosed plan, please contact the undersigned at Telephone No. 650-746-7451 or Internet e-mail: stephen.f.tyahla@navy.mil.

Sincerely

STEPHEN F. TYAHLA, P.E., CHMM
By Direction

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22 July 2004

Subj: DRAFT SAMPLING AND ANALYLSIS PLAN ADDITIONAL GROUNDWATER INVESTIGATION AT TIDAL AREAL LANDFILL, SITE 1, NAVAL WEAPONS STATION SEAL BEACH, DETACHMENT CONCORD, CONCORD, CALIFORNIA

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GENERAL SERVICES ADMINISTRATION
Contract Number: GS-10F-0076K
Delivery Order Number: N62474-01-F-6036

Sampling and Analysis Plan
(Field Sampling Plan/Quality Assurance Project Plan)
Additional Groundwater Investigation at
Tidal Area Landfill, Site 1

Naval Weapons Station Seal Beach Detachment Concord
Concord, California

DRAFT

GSA.032.003

July 22, 2004

Naval Facilities Engineering Command

Engineering Field Activity West
Naval Facilities Engineering Command
Daly City, California 94104-1976

TETRA TECH, INC.

GENERAL SERVICES ADMINISTRATION
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Draft

SAMPLING AND ANALYSIS PLAN

(Field Sampling Plan/Quality Assurance Project Plan)

ADDITIONAL GROUNDWATER INVESTIGATION AT TIDAL AREA LANDFILL, SITE 1

Naval Weapons Station Seal Beach Detachment Concord
Concord, California

July 22, 2004

Prepared for:

NAVFAC
Naval Facilities Engineering Command

DEPARTMENT OF THE NAVY
Engineering Field Activity West
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Draft

Sampling and Analysis Plan
(Field Sampling Plan/Quality Assurance Project Plan)
Additional Groundwater Investigation at Tidal Area Landfill, Site1
Naval Weapons Station Seal Beach Detachment Concord
Concord, California

Contract Number: GS-10F-0076K
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DEPARTMENT OF THE NAVY

REVIEW AND APPROVAL

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TABLE 1: ELEMENTS OF EPA QA/R-5 IN RELATION TO THIS SAP

Draft SAP, Additional Groundwater Investigation at Tidal Area Landfill, Site 1,
Naval Weapons Station Seal Beach Detachment Concord, Concord, California

EPA QA/R-5 QAPP ELEMENT[a]		SAP	
A1	Title and Approval Sheet	Title and Approval Sheet	
A2	Table of Contents	Table of Contents	
A3	Distribution List	Distribution List	
A4	Project/Task Organization	1.4	Project Organization
A5	Problem Definition/Background	1.1	Problem Definition and Background
A6	Project/Task Description	1.2	Project Description
A7	Quality Objectives and Criteria	1.3	Quality Objectives and Criteria
A8	Special Training/Certification	1.5	Special Training and Certification
A9	Documents and Records	1.6	Documents and Records
B1	Sampling Process Design	2.1	Sampling Process Design
B2	Sampling Methods	2.2	Sampling Methods
B3	Sample Handling and Custody	2.3	Sample Handling and Custody
B4	Analytical Methods	2.4	Analytical Methods
B5	Quality Control	2.5	Quality Control
B6	Instrument/Equipment Testing, Inspection, and Maintenance	2.6	Equipment Testing, Inspection, and Maintenance
B7	Instrument/Equipment Calibration and Frequency	2.7	Instrument Calibration and Frequency
B8	Inspection/Acceptance of Supplies and Consumables	2.8	Inspection and Acceptance of Supplies and Consumables
B9	Non-direct Measurements	2.9	Nondirect Measurements
B10	Data Management	2.10	Data Management
C1	Assessment and Response Actions	3.1	Assessment and Response Actions
C2	Reports to Management	3.2	Reports to Management
D1	Data Review, Verification, and Validation	4.1	Data Review, Verification, and Validation
D2	Validation and Verification Methods		
D3	Reconciliation with User Requirements	4.2	Reconciliation with User Requirements

Notes:

a	EPA. 2001. "EPA Requirements for Quality Assurance Project Plans, EPA QA/R-5." Office of Environmental Information. Washington, DC. EPA/240/B-01/003. March.
EPA	U.S. Environmental Protection Agency
QAPP	Quality assurance project plan
SAP	Sampling and analysis plan

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CONTENTS (Continued)

Appendix

FIGURES

TABLES

ACRONYMS AND ABBREVIATIONS

µg/kg	Micrograms per kilogram
µg/L	Micrograms per liter
µg/m^3	Micrograms per cubic meter
APHA	American Public Health Association
ASTM	American Society for Testing and Materials
AWQC	Ambient water quality criteria
bgs	Below ground surface
BTEX	Benzene, toluene, ethylbenzene, and total xylenes
29 CFR	Title 29 of the *Code of Federal Regulations*
CLP	Contract Laboratory Program
COC	Chain of custody
DDT	Dichlorodiphenyltrichloroethane
DDE	Dichlorodiphenyldichloroethene
DHS	California Department of Health Services
DO	Delivery Order
DQA	Data quality assessment
DQO	Data quality objective
DTSC	California Department of Toxic Substances Control
EDD	Electronic data deliverable
E&E	Ecology & Environment, Inc.
ELAP	Environmental Laboratory Accreditation Program
EPA	U.S. Environmental Protection Agency
ESL	Environmental screening level
FS	Feasibility study
FSP	Field sampling plan
FTL	Field team leader
GC/MS	Gas chromatography/mass spectrometry
GPC	Gel permeation chromatography
HASP	Health and safety plan
ICP	Inductively coupled plasma
ID	Identification
IDL	Instrument detection limit
IDW	Investigation-derived waste
IT	International Technology Corporation

ACRONYMS AND ABBREVIATIONS (Continued)

JMM	James M. Montgomery
L	Liter
L/min	Liter per minute
LCS	Laboratory control sample
LIMS	Laboratory information management system
LUFT	Leaking underground fuel tank
MCAWW	Methods for Chemical Analysis of Water and Waste
MCL	Maximum contaminant level
MDL	Method detection limit
mg/kg	Milligrams per kilogram
mg/L	Milligrams per liter
MQO	Measurement quality objective
MS	Matrix spike
MSD	Matrix spike duplicate
msl	Mean sea level
MSR	Monthly status report
NA	Not applicable
Navy	U.S. Department of the Navy
NEDTS	Navy Environmental Data Transfer Standards
NFESC	Naval Facilities Engineering Service Center
NWSSBD	Naval Weapons Station Seal Beach Detachment
OSHA	Occupational Safety and Health Administration
PAH	Polynuclear aromatic hydrocarbon
PARCC	Precision, accuracy, representativeness, completeness, and comparability
PCB	Polychlorinated biphenyl
PE	Performance evaluation
PPE	Personal protective equipment
PRC	PRC Environmental Management, Inc.
PRG	Preliminary remediation goal
PRRL	Project-required reporting limit
PVC	Polyvinyl chloride
QA	Quality assurance
QAPP	Quality assurance project plan
QC	Quality control
QCSR	Quality control summary report

ACRONYMS AND ABBREVIATIONS (Continued)

RfD	Reference dose
RI	Remedial investigation
RPD	Relative percent difference
RPM	Remedial project manager
RTC	Response to comment
RWQCB	California Regional Water Quality Control Board
SAP	Sampling and analysis plan
SDG	Sample delivery group
SI	Site investigation[bef1]
SOP	Standard operating procedure
SOW	Statement of work
SQL	Sample quantitation limit
SWDIV	Naval Facilities Engineering Command, Southwest Division
SVOC	Semivolatile organic compound
TBD	To be determined
TDS	Total dissolved solid
Tetra Tech	Tetra Tech EM Inc.
TPH	Total petroleum hydrocarbons
TPH-e	TPH-extractable
TPH-p	TPH-purgeable
TIC	Tentatively identified compound
TSA	Technical systems audit
UXO	Unexploded ordnance
VOC	Volatile organic compound

1.0 PROJECT DESCRIPTION AND MANAGEMENT

Tetra Tech EM Inc. (Tetra Tech) is submitting this "Draft Sampling and Analysis Plan [SAP] for Additional Investigation of Groundwater at the Tidal Area Landfill (Site 1), Naval Weapons Station Seal Beach Detachment (NWSSBD) Concord" at the direction of the U.S. Department of the Navy (Navy), Naval Facilities Engineering Command, Engineering Field Activity West, under General Services Administration Contract No. GS-10F-0076K.

As part of this work, Tetra Tech will install and develop five monitoring wells along the perimeter of the Tidal Area Landfill. These five new monitoring wells, seven existing wells, and three existing piezometers will be sampled to evaluate chemical concentrations in groundwater that may be migrating from the landfill. The Tidal Area Landfill (Site 1) is located in the Tidal Area of Naval NWSSBD Concord in Concord, California (Figure 1). Tetra Tech prepared this sampling and analysis plan, consisting of a field sampling plan (FSP) and a quality assurance project plan (QAPP), in an integrated format to guide the field, laboratory, and data reporting efforts associated with this project.

Table 1 follows the approval page at the beginning of this SAP. The table demonstrates how this SAP addresses all the elements of a QAPP currently required by the U.S. Environmental Protection Agency (EPA) QA/R-5 guidance document (EPA 2001).

Tables and figures follow their first reference in the text in this document. Appendix A contains method precision and accuracy goals. Appendix B contains Tetra Tech's standard operating procedures (SOPs) and field forms. Appendix C lists project-required reporting limits (PRRL), and Appendix D lists Navy-approved laboratories that Tetra Tech has contracted to analyze samples collected under Navy contracts.

1.1 PROBLEM DEFINITION AND BACKGROUND

This section describes the following:

- Purpose of the Investigation (Section 1.1.1)
- Problem to be Solved (Section 1.1.2)
- Facility Background (Section 1.1.3)
- Physical Setting and Site Description (Section 1.1.4)
- Summary of Previous Investigations (Section 1.1.5)
- Geologic and Hydrogeologic Conditions (Section 1.1.6)
- Principal Decision-Makers (Section 1.1.7)
- Technical or Regulatory Standards (Section 1.1.8)

Figure 1

This detailed station map has been deleted from the Internet-accessible version of this document as per Department of the Navy Internet security regulations.

1.1.1 Purpose of the Investigation

The purpose of this investigation is to install additional monitoring wells in areas that will help to address potential groundwater data gaps, and to collect data that in combination with historical data, will allow the evaluation of groundwater at the Tidal Area Landfill. This evaluation is intended to assess whether constituents within the landfill are leaching to groundwater at concentrations that exceed estimated ambient levels or water quality screening criteria. In addition, aquifer tests (slug tests) will be conducted in two existing wells and the new monitoring wells that are of sufficient diameter for slug testing. These slug tests will provide information regarding hydraulic conductivity.

1.1.2 Problem to be Solved

The Tidal Area Landfill is a potential source of contamination because the existing waste will be abandoned in place below a surface landfill cap. Because of the potential for chemicals in the landfill to leach to groundwater, an evaluation of chemical concentrations in groundwater migrating from the landfill is needed. Existing monitoring wells have been completed at several locations around the perimeter of the landfill. Additional monitoring wells are needed, however, to address data gaps and to complete the network of wells to monitor water quality along the perimeter of the landfill.

1.1.3 Facility Background

NWSSBD Concord was historically a major naval munitions transshipment facility. NWSSBD Concord is located in the north-central portion of Contra Costa County, California, 30 miles northeast of San Francisco (Figure 1). The facility, which encompasses 13,000 acres, is bounded to the north by Suisun Bay, to the east by Los Medanos Hills and the City of Pittsburg, and to the south and west by the City of Concord. Currently, the facility is made up of two main separate land holdings: the Tidal Area (which includes islands in Suisun Bay) and the Inland Area. Although the base is officially active, it is operating in a reduced capacity and has been since 1999.

In December 1942, the Navy commissioned the ordnance-shipping depot at Naval Magazine, Port Chicago, now known as the Tidal Area of NWSSBD Concord. When munitions passing through the Port Chicago waterfront began to exceed the capacity of the facility, the Navy acquired a 5,143-acre parcel of land in Diablo Creek Valley. This land became the Inland Area of NWSSBD Concord.

Current operations at NWSSBD Concord are associated primarily with routine ammunition transshipment and storage. The facility's current active tenant, the U.S. Department of the Army, limits these activities to the Tidal Area. Military operations require "explosive safety arcs," so that large tracts of land at NWSSBD Concord function as a buffer for military operations and are therefore mostly vacant. Although the Army controls daily activities at the site, the Navy retains responsibility for environmental restoration at the facility. No current plans exist for any change in land use or ownership of the facility.

1.1.4 Physical Setting and Site Description

The Tidal Area Landfill, which covers 13 acres, is located along the western side of Johnson Road, just north of Froid Road (Figure 1). The landfill served as the major disposal area for NWSSBD Concord from approximately 1944 to 1979. As shown by the growth of the landfill perimeter in historical aerial photographs, most of the waste was deposited from 1959 to 1974. Household garbage from NWSSBD Concord and surrounding communities was disposed of at the landfill. In addition, the landfill reportedly received solvents, acids, paint cans, creosote-treated timbers, asphalt, concrete, asbestos, and ordnance materials, including inert munitions (Ecology and Environment [E&E] 1983). Shipboard wastes were reportedly disposed of in the landfill (E&E 1983). In addition, the tritonal (trinitrotoluene and aluminum powder) filler from one, 750-pound, general-purpose bomb was reportedly buried there; however, the Navy considers it possible but highly unlikely that tritonal filler was disposed of in the landfill (Tetra Tech 1998a).

Historical photographs indicate that the Tidal Area Landfill was created by the progressive disposal of soil and debris outward from Johnson Road. The soil and debris were placed on native soil. A waste thickness of up to 10 feet was estimated from topographic evaluation; however, the waste may be unevenly distributed, and the ratio of waste to soil cover in the fill may be variable (International Technology Corporation [IT] 1992). The origin of the soil cover is unknown. Geotechnical evaluation of the site for the feasibility study (FS) indicated that the landfill is situated on highly compressible Bay Mud that is susceptible to significant future settlement as a result of new loads. There is no record of the degree of historical subsidence of the landfill. Currently, a fence borders the edge of the landfill along Johnson Road.

The horizontal extent of the Site 1 landfill has been established based on historical aerial photographs and visual site inspection. The boundary of the landfill on the east side is defined by a road; on the south, north, and west sides, the boundary is visually apparent and is defined by a sudden change in slope from the flat wetland into the raised mound of the landfill material. The surface of the landfill at Site 1 was delineated as an upland area (Western Ecological Services Company, Inc. 1995), with a salt marsh wetland along the western and southern boundaries of the landfill.

The surface of the landfill supports vegetation and habitat that consists predominantly of ruderal, nonnative grassland. The surface of the landfill is made up of a discontinuous soil cover mixed with waste throughout the depth of the landfill. Rubble, metal scraps, and wood debris are currently visible through the soil layer. Differential subsidence from degraded waste and non-uniform waste characteristics has resulted in a highly uneven surface interrupted by deep potholes. Land west and north of the Tidal Area landfill consists of a partially flooded marsh. In the late 1980s, this area dried back every summer to reveal a vegetated marsh surface. It appears that the site no longer dries to the same extent, and the inundated plant community has died.

1.1.5 Summary of Previous Investigations

A site investigation (SI) was conducted by IT from 1988 to 1992 to confirm or refute the presence of contamination and to make a preliminary evaluation of potential risks associated with each site. As a part of the SI, 10 borings were drilled in the landfill; seven monitoring wells were installed along the perimeter of the landfill; and samples of soil, sediment, groundwater, and surface water were collected and analyzed. Results for the landfill are discussed in detail in a 1992 SI report (IT 1992). Significant findings for the samples of soil, sediment, and surface water are briefly summarized below.

Soil samples were collected at 10 locations along north-south and east-west transects through the center of the landfill at depths of up to 11 feet below grade. Several organic compounds, including polynuclear aromatic hydrocarbons (PAH) and toluene, were detected at various depths and locations within the landfill at concentrations up to 39,000 micrograms per kilogram (µg/kg) PAHs and 25 µg/kg toluene. Aroclor-1260, a polychlorinated biphenyl (PCB), was detected in a sample collected at one location at an estimated concentration of 1,800 µg/kg. Elevated concentrations of lead (maximum of 4,550 milligrams per kilogram [mg/kg) and copper (up to 4,730 mg/kg) were detected in samples collected at several locations in the landfill.

Sediment samples collected from two locations southwest of the landfill contained slightly elevated concentration of arsenic and zinc. Surface water samples collected from the same two locations reportedly exhibited low pH (1.6 to 2.5) and elevated concentration of salts in surface water.

The Navy conducted a remedial investigation (RI) in the tidal area from 1993 to 1997 to evaluate the nature and extent of contamination at the Tidal Area Landfill and three other Tidal Area sites. During the RI, surface and subsurface soil samples were collected around the perimeter of the landfill to assess whether chemicals may be migrating from the landfill. Eight locations were sampled, and 24 samples were analyzed; only one organic compound was detected in soil at a concentration greater than the EPA Region 9 residential preliminary remediation goal (PRG) (EPA 2000f): the PAH benzo(a)pyrene was detected in a surface soil sample from the western edge of the landfill. Three metals (arsenic, beryllium, and lead) were detected at concentrations that exceeded residential PRGs and estimated ambient concentrations: arsenic and beryllium in surface and subsurface soil samples, and lead in surface soil samples. The Navy and regulatory agencies agreed that pursuing a "presumptive remedy" per EPA guidance was appropriate. Therefore, the contents of the landfill were not characterized during the RI. The results are documented in detail in the RI report (Tetra Tech 1999).

Monitoring wells at the Tidal Area Landfill were sampled quarterly from May 1990 to January 1991 for analysis of volatile organic compounds (VOC), semivolatile organic compounds (SVOC), metals, pesticides and PCBs, anions, total organic carbon, and total dissolved solids (TDS) as part of the SI (IT 1992). Metals of potential concern, including arsenic, copper, lead, nickel, and silver, were inconsistently detected in samples from the seven Tidal Area Landfill monitoring wells. Organic compounds were not detected consistently in samples from any wells.

Limited confirmation samples were collected from wells TLSMW001 and TLSMW002 in 1993 (James M. Montgomery, Consulting Engineers, Inc. 1993). The confirmation samples were analyzed only for VOCs and SVOCs. Organic compounds were not detected in any of the 1993 confirmation samples (PRC Environmental Management, Inc. [PRC] and Montgomery Watson 1993). A low-flow rate sampling study was conducted in 1994 to address concerns about sampling techniques for metals. Two sets of filtered and unfiltered samples were collected from four wells in the Tidal Area, including well TLSMW003 at the Tidal Area Landfill. The low-flow rate study proved inconclusive; results are documented in a technical memorandum (Montgomery Watson 1994).

In September and October 1997, the Navy conducted a confirmation groundwater sampling study to address outstanding issues about groundwater in the Tidal Area (Tetra Tech 1998b). This confirmation study included sampling of Tidal Area monitoring wells and analysis for metals, organic compounds, and radionuclide isotopes. Metals were detected at the highest concentrations within the R Area disposal site and north central part of the Wood Hogger site. The confirmation study found that Tidal Area groundwater was not affected by organic compounds or radionuclide isotopes to any significant extent (Tetra Tech 1998b). The groundwater confirmation study also included a tidal influence survey and installation of piezometers to better define geologic conditions in the area east of the Tidal Area Landfill.

Groundwater samples were collected between July 22 and 25, 2003 to investigate metal, volatile organic compound (VOC), semivolatile organic compound (SVOC), total petroleum hydrocarbon (TPH), and perchlorate concentrations in groundwater at Site 1. The primary objective of the July 2003 sampling effort was to confirm that the formation and migration of leachate from the landfill has not occurred since groundwater was last sampled in 1997. Aluminum, arsenic, copper, mercury, nickel, and zinc were all detected above groundwater screening criteria at one or more locations. Detected metals were compared with ambient water quality criteria or Bay Basin Plan objectives (California Regional Water Quality Control Board [RWQCB] 1995). A statistical comparison between the 1997 and 2003 groundwater sampling events showed no significant change in the concentrations of arsenic, mercury, and nickel at the Site 1 monitoring wells. A statistically significant difference existed between groundwater concentrations of aluminum, copper, iron, thallium, and zinc in samples collected during 1997 and 2003. However, the higher concentrations of these metals, collected in 2003, are likely an artifact of total suspended solids (TSS) in samples.

VOCs were not detected in groundwater during the July 2003 sampling event, except for carbon disulfide; carbon disulfide is a VOC commonly found in wetland habitat and may be related to the decomposition of plant material. SVOCs were not detected in any groundwater samples collected during this sampling effort. TPH was not detected in groundwater except for one sample with an estimated concentration of 0.03 milligrams per liter of gasoline-range hydrocarbons. Perchlorate was not detected in any groundwater samples collected from Site 1.

1.1.6 Geologic and Hydrogeologic Conditions

The geologic conditions at the Tidal Area Landfill consist mainly of artificial fill soils and landfill waste deposited over a marshland. The marshland soils consist primarily of Bay Mud, generally described as a dark gray to black silty clay, clayey silt, or silt. The Bay Mud typically exhibits low permeability, restricting movement of groundwater and causing low recharge in wells screened in the formation.

Occasional sand lenses exist within the Bay Mud, but their lateral extent appears limited; most were recorded in a single soil boring and were not encountered in adjacent borings (Tetra Tech 1998b). The only sand lenses that could be correlated between adjacent borings occur near the eastern margin of the landfill. Two of the shallow sand lenses encountered in boring B-9 (well TLSMW005) correlated with similar sand lenses encountered in the boring for piezometer RADPZ006. A deeper sand body of limited lateral extent was encountered at depths of approximately 16 to 18 feet below ground surface (bgs) in piezometers RADPZ003, RADPZ004, and RADPZ006 (Figure 2).

The Tidal Area Landfill was constructed over the former channel of Otter Sluice in the southwestern portion of the landfill (Figure 2). The fill material in the channel may consist of soil that is coarser grained than the surrounding Bay Mud (Tetra Tech 1998b) that could act as a preferential pathway for groundwater flow. Therefore, two of the proposed monitoring wells, TLSMW010 and TLSMW011, will be installed within the former channel of Otter Sluice along the southwestern perimeter of the Tidal Area Landfill to assess potential contaminant migration through the channel fill.

Seven monitoring wells and six piezometers have been installed at Site 1 (Figure 2). Table 2 presents information on well construction for each of the existing wells and piezometers.

Groundwater at Site 1 occurs in a shallow, unconfined water-bearing zone that is predominantly composed of silty clays in the Bay Mud. The primary mode of shallow groundwater flow appears to be through the silty clay materials. Based on a hand auger survey and borings installed northeast of the landfill, the technical memorandum on confirmation groundwater sampling (Tetra Tech 1998b) concluded that linear bodies of sandy fill material did not appear to act as preferential pathways for groundwater flow.

Figure 2

This detailed station map has been deleted from the Internet-accessible version of this document as per Department of the Navy Internet security regulations.

TABLE 2: CONSTRUCTION DETAILS FOR EXISTING WELLS

Draft SAP, Additional Groundwater Investigation at Tidal Area Landfill, Site 1,
Naval Weapons Station Seal Beach Detachment Concord, Concord, California

Well or Piezometer	Year Installed	Well Diameter (inches)	Slot Size (inches)	Well Screen Depth Interval (feet bgs)	Total Depth of Sand Backfill (feet bgs)	Soil Materials in Screened Section
TLSMW001	1989	4	0.010	4 - 14	15	Silty clay
TLSMW002	1989	4	0.010	4 - 14	15	Silty clay
TLSMW003	1989	4	0.010	4 - 14	15	Silty clay
TLSMW004	1989	4	0.010	8 - 18	20	Silty clay and clayey sand
TLSMW005	1989	4	0.010	7 - 17	20	Silty clay and clayey sand
TLSMW006	1989	4	0.010	7 - 17	20	Silty clay and pebbles
TLSMW007	1989	4	0.010	4 - 14	15	Silty clay
RADPZ001	1995	2	0.010	1 - 6	6	Unknown[a]
RADPZ002	1995	2	0.010	1 – 6	6	Unknown[a]
RADPZ003	1997	4	0.010	11 – 21	22	Silty sand and silty clay
RADPZ004	1997	4	0.010	10 – 20	21	Sand and silty clay
RADPZ005	1997	4	0.010	5 – 15	15	Silty clay
RADPZ006	1997	4	0.010	15 - 25	26	Sand, silt, and silty clay

Notes:

a These piezometers were driven into place; soil was not sampled during installation

bgs Below ground surface

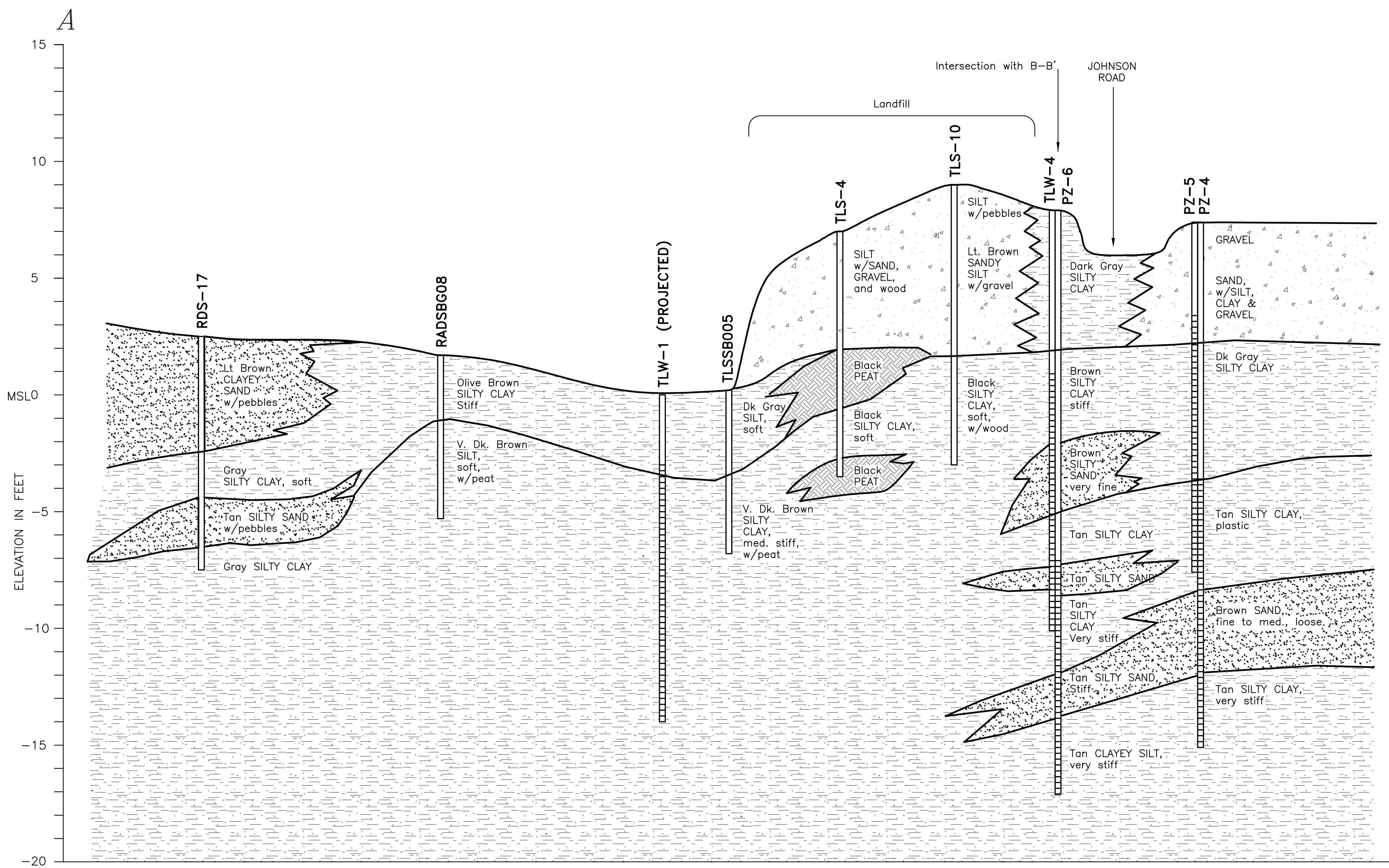
Groundwater in the shallow water-bearing zone at Site 1 generally flows to the west. Water level surveys conducted during the confirmation groundwater sampling (Tetra Tech 1998b) found that groundwater flowed toward a closed depression in the center of the R Area Disposal site. Groundwater did not appear to discharge to Suisun Bay via subsurface slow or interaction of groundwater and surface water, although limited interaction occurs along a narrow strip adjacent to Otter Sluice (Tetra Tech 1998b).

In addition to the shallow silty clay water-bearing zone, groundwater occurs in a subsurface sand body enclosed within silty clay in the area east of the landfill. The sand body is about 3.5 feet thick in piezometers RADPZ003 and RADPZ004 and appears to pinch out to the west, in the vicinity of the landfill (Figures 3, 4, and 5). The sand unit was about 1.5 feet thick in piezometer RADPZ006 and was not present in boring B-9 (Figure 2). The lateral extent of the sand body east of piezometers RADPZ003 and RADPZ004 is unknown (Tetra Tech 1998b). Differences in water levels between wells in the shallow silty clay and the sand unit indicate that groundwater is under confined conditions in the sand unit. The hydraulic gradient in the confined sand unit is to the northwest during both the dry and wet seasons.

Site-specific hydraulic conductivities were obtained by slug testing for wells TLSMW001, TLSMW003, and TLSMW005 during the SI at Site 1. The hydraulic conductivities range from 1.6 to 8.0 centimeters per second (IT 1992).

Figure 3

This detailed station map has been deleted from the Internet-accessible version of this document as per Department of the Navy Internet security regulations.



NOTE:

THIS CROSS–SECTION REPRESENTS ONE INTERPRETATION BASED ON AVAILABLE DATA, OTHER INTERPRETATIONS ARE POSSIBLE

HORIZONTAL SCALE

300' 0 150' 300'

SCALE IN FEET

VERTICAL SCALE = 20 x HORIZONTAL SCALE

Naval Weapons Station Seal Beach Detachment
Concord, California
EFA West, Daly City, CA

FIGURE 4
GEOLOGIC CROSS SECTION A-A'

Tidal Area Landfill
Additional Groundwater Investigation

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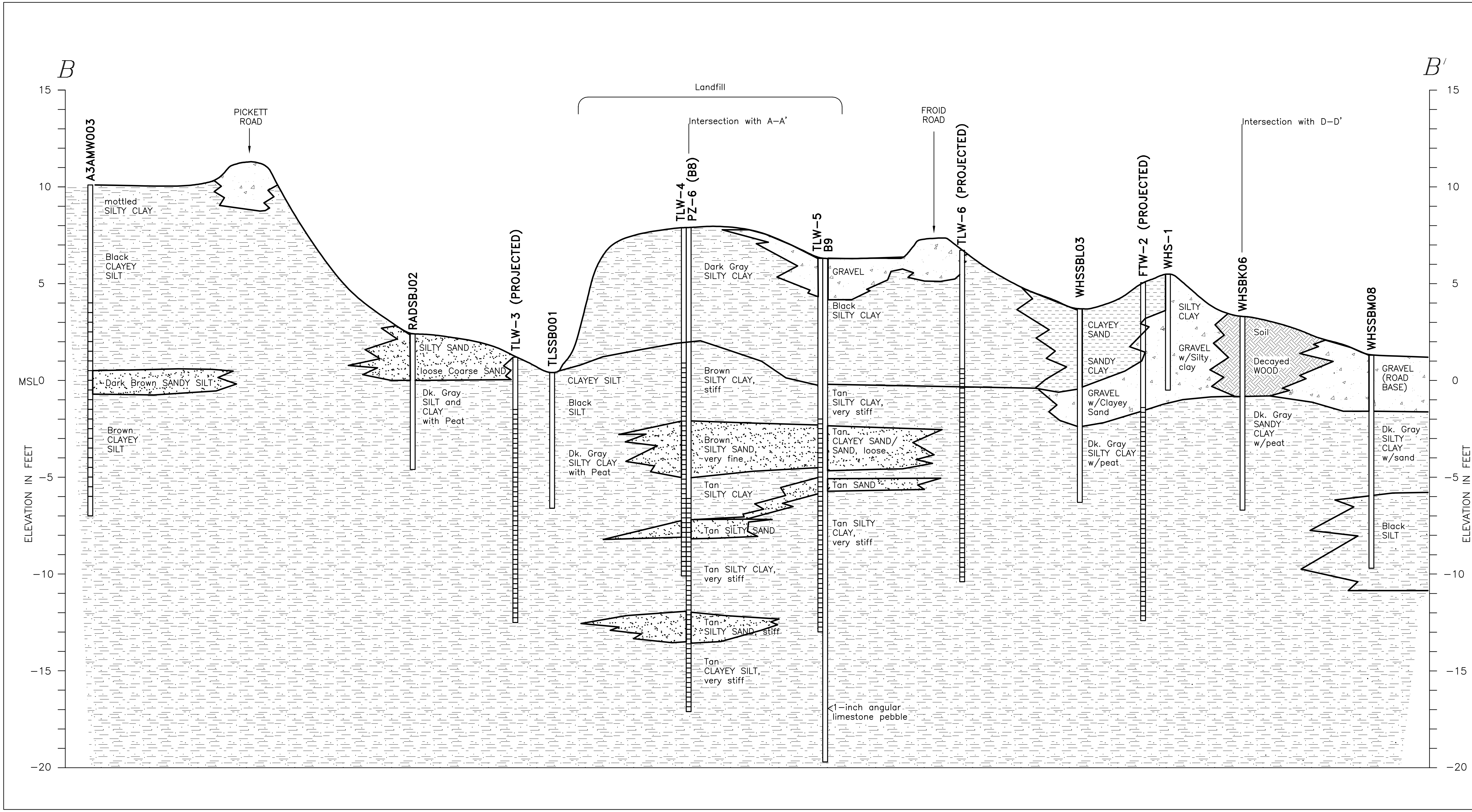

NOTE:

THIS CROSS–SECTION REPRESENTS ONE INTERPRETATION BASED ON AVAILABLE DATA, OTHER INTERPRETATIONS ARE POSSIBLE

HORIZONTAL SCALE

300' 0 150' 300'

SCALE IN FEET

VERTICAL SCALE = 20 x HORIZONTAL SCALE

Naval Weapons Station Seal Beach Detachment
Concord, California
EFA West, Daly City, CA

FIGURE 5
GEOLOGIC CROSS SECTION B-B'

Tidal Area Landfill
Additional Groundwater Investigation

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1.1.7 Principal Decision-Makers

Principal decision-makers include the Navy, the regulatory agencies (EPA Region 9, the California Environmental Protection Agency Department of Toxic Substances Control [DTSC], and the Regional Water Quality Control Board [RWQCB]), and the public. These decision-makers will use the data collected from this project in conjunction with data generated during previous investigations to evaluate whether additional work is required to address groundwater at the Tidal Area Landfill.

1.1.8 Technical or Regulatory Standards

Chemical constituent concentrations in groundwater samples will be compared with previous sampling results to assess impacts to groundwater. Data from samples collected upgradient and downgradient from the landfill will be compared to evaluate whether leachate is migrating from the landfill. Temporal and spatial comparisons will also be made.

Data will be compared with various criteria such as EPA Region 9 PRGs for tap water (EPA 2002b) and EPA drinking water maximum contaminant levels (EPA 2002c). These criteria have not been identified as directly applicable in the past, however, because of the hypersaline conditions detected over many years of sampling in the area next to the Tidal Area Landfill. Concentrations in groundwater will also be compared with EPA's national recommended water quality criteria (EPA 2002d), EPA's State of California water quality criteria (California Toxics Rule (EPA 2000c), and the Bay Basin plan objectives upstream of San Pablo Bay (RWQCB 1995). Because these criteria are not directly applicable to the site conditions, they will be used only for reference.

1.2 PROJECT DESCRIPTION

This section discusses the objectives and measurements of the project.

1.2.1 Project Objectives

As stated in Section 1.1.1, the purpose of this investigation is to install additional monitoring wells that will be used to address potential data gaps and to collect data. This effort is part of the ongoing evaluation of the Tidal Area Landfill to assess whether chemicals are leaching to groundwater and migrating from the landfill at concentrations that exceed estimated ambient levels or water quality screening criteria.

The work will be conducted in several phases, as summarized below:

- Install and develop five monitoring wells. Two of the wells will be installed in former channels of Otter Sluice along the southwestern perimeter of the landfill.
- Survey new wells and measure groundwater levels in the five new and 10 existing Tidal Area Landfill wells and piezometers[RTO3].

- Sample the five new monitoring wells, seven existing monitoring wells, and three existing piezometers [RTO4]during the first quarterly sampling event. During the first quarterly sampling event, the groundwater samples will be analyzed for metals, hexavalent chromium[RTO5], mercury, VOCs, SVOCs, pesticides, explosives, perchlorate, extractable total petroleum hydrocarbons (TPH), purgeable TPH, 1,4 dioxane, 1,2,3-trichloropropane, total dissolved solids, total suspended solids, and general anions.

- Sample the five new monitoring wells during second- through fourth-quarter sampling events. During the second- through fourth-quarter sampling events, the groundwater samples will be analyzed for metals, mercury, VOCs, SVOCs, perchlorate, extractable TPH, purgeable TPH, 1,4 dioxane, 1,2,3-trichloropropane, total dissolved solids, total suspended solids, and general anions. Samples will be analyzed for hexavalent chromium, pesticides, explosives, and 1,4-dioxane only if the compounds are detected during the first-quarter sampling event.

- Conduct aquifer (slug) tests in existing well TLSMW004, existing piezometer RADPZ006, and each of the five new monitoring wells that are of sufficient diameter for slug testing.

Table 3 presents the implementation schedule for the investigation.

TABLE 3: IMPLEMENTATION SCHEDULE FOR SAMPLING, ANALYSIS, AND REPORTING

Draft SAP, Additional Groundwater Investigation at Tidal Area Landfill, Site 1,
Naval Weapons Station Seal Beach Detachment Concord, Concord, California

Milestone	Due Date	Anticipated Date
Draft SAP to Agencies	July 23, 2004	July 23, 2004
Receipt of Agency Comments on Draft SAP	60 calendar days after SAP is submitted to agencies	September 21, 2004
Draft Final SAP and RTCs	62 calendar days after agency comments are received	November 22, 2004
HASP to Navy	30 calendar days before field investigation to begin	December 22,2004
Final SAP	30 calendar days after draft final SAP is submitted to agencies	December 22, 2004
Field Work (includes four quarters of groundwater monitoring)	270 calendar days after agency concurrence on SAP	January 22 through October 22, 2005
Draft Groundwater Study Report	90 calendar days after validated analytical data from groundwater sampling are received	March 6, 2006

Notes:

HASP Health and Safety Plan
RTC Responses to comments
SAP Sampling and analysis plan

1.2.2 Project Measurements

Project measurements will include various field measurements as well as laboratory analysis of groundwater samples. The laboratory will also analyze quality control (QC) samples and investigation-derived waste (IDW) samples. These measurements are discussed in detail in Section 2.0 of this SAP.

1.3 QUALITY OBJECTIVES AND CRITERIA

This section summarizes the data quality objectives (DQO) and measurement quality objectives (MQO) identified for this project.

1.3.1 Data Quality Objectives

DQOs are qualitative and quantitative statements developed through the seven-step DQO process (EPA 2000b, 2000e). DQOs clarify the study objective, define the most appropriate data to collect and the conditions under which to collect the data, and specify tolerable limits on decision errors that will be used as the basis for establishing the quantity and quality of data needed to support decision-making. The DQOs are used to develop a scientific and resource-effective design for data collection. Table 4 presents the seven steps of the DQO process for this project.

1.3.2 Measurement Quality Objectives

All analytical results will be evaluated in accordance with precision, accuracy, representativeness, completeness, and comparability (PARCC) parameters to document the quality of the data and to ensure that the data are of sufficient quality to meet the project objectives. Of these PARCC parameters, precision and accuracy will be evaluated quantitatively by collecting the QC samples listed in Table 5. Appendix A lists the specific precision and accuracy goals for the QC samples.

The sections below describe each of the PARCC parameters and how they will be assessed within this project.

1.3.2.1 Precision

Precision is the degree of mutual agreement between individual measurements of the same property under similar conditions. Combined field and laboratory precision is evaluated by collecting and analyzing field duplicates and then calculating the variance between the results for the samples, typically as a relative percent difference (RPD), using the equation presented below.

$$RPD = \frac{|A-B|}{(A+B)/2} \; x \; 100\%$$

where:

A = First duplicate concentration
B = Second duplicate concentration

TABLE 4: DATA QUALITY OBJECTIVES

Draft SAP, Additional Groundwater Investigation at Tidal Area Landfill, Site 1,
Naval Weapons Station Seal Beach Detachment Concord, Concord, California

STEP 1: State the Problem

- Contaminants may be migrating from the Tidal Area Landfill (Site 1) through groundwater.

STEP 2: Identify the Decisions

1. Are contaminants in groundwater migrating from the Tidal Area Landfill (Site 1)?
2. Do chemical concentrations in groundwater migrating from the Tidal Area Landfill exceed water quality screening criteria?

STEP 3: Identify Inputs to the Decisions

- Results from previous investigations.
- Review of historical and current aerial photographs.
- Results from groundwater level measurements and quarterly groundwater sampling.
- Results from aquifer (slug) tests.
- Comparison with appropriate screening criteria.

STEP 4: Define Study Boundaries

- The lateral extent of this investigation is the Tidal Area Landfill and surrounding environments.
- The vertical extent of this investigation extends from surface water to the depth of the existing monitoring wells installed at the Tidal Area Landfill.
- Temporal boundaries extend through the period of performance of the delivery order.

STEP 5: Develop Decision Rules

1. If chemical concentrations in groundwater samples collected downgradient of the Tidal Area Landfill are greater than the concentrations in groundwater from upgradient wells[RTO6], then it will be assumed that contaminants are migrating from the Tidal Area Landfill. Upgradient and downgradient results will be compared using the Wilcoxon Signed-Rank test. Otherwise, it will be assumed that contamination is not migrating from the Tidal Area Landfill.
2. If chemical concentrations in groundwater samples collected within potential contaminant migration pathways at the edge of the Tidal Area Landfill exceed water quality screening criteria[RTO7], then further action is needed for groundwater. Otherwise, no further action other than long-term monitoring consistent with landfill closure requirements is required.

STEP 6: Specify Tolerable Limits on Decision Errors

Site-specific sampling objectives and the media investigated limit the use of statistical methods in selecting sampling locations for this investigation. Sampling locations will be selected based on historical source areas, site hydrogeology, and previous water quality data. Sample results from upgradient and downgradient wells will be compared using the Wilcoxon Signed-Rank test. No tolerable decision error rates were set because the judgmental sampling approach does not allow for the assessment of whether specific error rate limits have been attained[RTO8].

STEP 7: Optimize the Sampling Design

- Install two additional water table monitoring wells along the western side of the Tidal Area Landfill, near the planned edge of the landfill cap.
- Install one additional water table well north of the Tidal Area Landfill.
- Confirm the locations of the former channels of Otter Sluice that extended beneath the landfill. Install two additional water table monitoring wells within the former channels near the southern perimeter of the landfill.
- Measure water levels at the new and existing Tidal Area Landfill monitoring wells on a quarterly basis.
- Collect and analyze groundwater samples from each of the newly installed monitoring wells during four quarterly sampling events.
- Collect and analyze groundwater samples from seven existing Tidal Area Landfill wells and 3 existing piezometers during the first quarterly sampling event.
- Conduct aquifer (slug) tests in existing well TLSMW004, existing piezometer RADPZ006, and each of the five newly installed wells that are of sufficient diameter for conducting slug testing.

TABLE 5: QUALITY CONTROL SAMPLES FOR PRECISION AND ACCURACY

Draft SAP, Additional Groundwater Investigation at Tidal Area Landfill, Site 1,
Naval Weapons Station Seal Beach Detachment Concord, Concord, California

QC Type	Precision	Accuracy	Frequency
Field QC	Field Duplicate	Field Duplicate	One per 10 samples collected
		Equipment Rinsate	One per day per type of sampling equipment
		Source Water Blank	One per day per types of source of water used for the final decontamination rinse
		Trip Blank	One per transport container with samples for analysis of VOCs and TPH purgeable
		Temperature Blank	One per transport container with samples for analysis of VOCs and TPH purgeable
Laboratory QC	MS/MSD RPD	MS/MSD %R	One per 20 samples
		Method Blanks	One per 20 samples
		LCS or Blank Spikes	One per 20 samples
		Surrogate Standards %R	Every sample for organic analysis by GC
		Internal Standards %R	Every sample for organic analysis by GC/MS

Notes:

%R Percent recovery
GC Gas chromatography
GC/MS Gas chromatography and mass spectroscopy
LCS Laboratory control sample
MS/MSD Matrix spike/matrix spike duplicate
QC Quality control
RPD Relative percent difference

Field sampling precision is evaluated by collecting field duplicate samples.

Laboratory analytical precision is evaluated by analyzing laboratory duplicates or matrix spikes (MS) and matrix spike duplicates (MSD). The results of the analysis of each MS/MSD pair will be used to calculate an RPD for evaluating precision.

1.3.2.2 Accuracy

A program of sample spiking will be conducted to evaluate laboratory accuracy. This program includes analysis of the MS and MSD samples, laboratory control samples (LCS) or blank spikes, surrogate standards, and method blanks. MS and MSD samples will be prepared and analyzed at a frequency of 5 percent for soil samples. LCS or blank spikes are also analyzed at a frequency of 5 percent. Surrogate standards, where available, are added to every sample analyzed for organic compounds. Results of the spiked samples are used to calculate the percent recovery for evaluating accuracy.

$$Percent\ \ Recovery = \frac{S - C}{T} \ \ x \ \ 100$$

where:

S = Measured spike sample concentration
C = Sample concentration
T = True or actual concentration of the spike

Appendix A presents accuracy goals for the investigation based on the percent recovery of matrix and surrogate spikes. Results that fall outside the accuracy goals will be further evaluated based on the results of other QC samples.

1.3.2.3 Representativeness

Representativeness expresses the degree to which sample data accurately and precisely represent the characteristics of a population, variations in a parameter at a sampling point, or an environmental condition that they are intended to represent. For this project, representative data will be obtained through careful selection of sampling locations and analytical parameters. Representative data also will be obtained through proper collection and handling of samples to avoid interference and minimize contamination.

Representativeness of data will be ensured through the consistent application of established field and laboratory procedures. Equipment rinsate blanks and laboratory blank samples will be evaluated for the presence of contaminants to aid in assessing the representativeness of analytical results. Data determined to be nonrepresentative based on comparison with existing data will be used only if accompanied by appropriate qualifiers and limits of uncertainty.

1.3.2.4 Completeness

Completeness is a measure of the percentage of project-specific data that are valid. Valid data are obtained when samples are collected and analyzed in accordance with QC procedures outlined in this SAP and when none of the QC criteria that affect data usability are exceeded. When all data validation is completed, the percent completeness value will be calculated by dividing the number of useable sample results by the total number of sample results planned for this investigation.

Completeness also will be evaluated as part of the data quality assessment process (EPA 2000d). This evaluation will help determine whether any limitations are associated with the decisions to be made based on the data collected.

1.3.2.5 Comparability

Comparability expresses the confidence with which one data set can be compared with another. Comparability of data will be achieved by consistently following standard field and laboratory procedures and by using standard measurement units in reporting analytical data.

1.3.2.6 Detection and Quantitation Limits

The method detection limit (MDL) is the minimum concentration of an analyte that can be reliably distinguished from background noise for a specific analytical method. The quantitation limit represents the lowest concentration of an analyte that can be accurately and reproducibly quantified in a sample matrix. PRRLs are contractually specified maximum quantitation limits for specific analytical methods and sample matrices, such as soil or water, and are typically several times the MDL to allow for matrix effects. PRRLs, which Tetra Tech establishes in the scope of work for subcontract laboratories, are minimum criteria for laboratory performance; actual laboratory quantitation limits may be substantially lower.

1.4 PROJECT ORGANIZATION

Table 6 presents the responsibilities and contact information for key personnel involved in this investigation. In some cases, more than one responsibility has been assigned to one person. Figure 6 presents the organization of the project team.

1.5 SPECIAL TRAINING AND CERTIFICATION

This section outlines the training and certification required to complete the activities described in this SAP and the requirements for Tetra Tech and subcontractor personnel working on site.

1.5.1 Health and Safety Training

Tetra Tech personnel who work at hazardous waste project sites are required to meet Occupational Safety and Health Administration (OSHA) training requirements defined in Title 29 of the *Code of Federal Regulations* (29 CFR) Part 1910.120(e). These requirements include (1) 40 hours of formal off-site instruction, (2) a minimum of 3 days of actual on-site field experience under the supervision of a trained and experienced field supervisor, and (3) 8 hours of annual refresher training. Field personnel who directly supervise employees engaged in hazardous waste operations also receive at least 8 additional hours of specialized supervisor training. The supervisor training covers health and safety program, training, personal protective equipment (PPE), spill containment program requirements, and health-hazard monitoring procedures and techniques. At least one member of the field team will maintain current certification in the American Red Cross “Multimedia First Aid” and “Cardiopulmonary Resuscitation Modular,” or equivalent.

TABLE 6: KEY PERSONNEL

Draft SAP, Additional Groundwater Investigation at Tidal Area Landfill, Site 1, Naval Weapons Station Seal Beach Detachment Concord, Concord, California

Name	Organization	Role	Responsibilities	Contact Information
Steve Tyahla	Navy	Remedial project manager	Responsible for overall project execution and coordination with base representatives, regulatory agencies, and Navy management personnel. Participates actively in the DQO process. Provides management and technical oversight during data collection.	Naval Facilities Engineering Command, Engineering Field Activity West, San Bruno, CA stephen.f.tyahla@navy.mil (650) 746-7451
Narciso A. Ancog	Navy	QA officer	Responsible for QA issues for all SWDIV environmental work. Provides government oversight of the Tetra Tech QA program. Reviews and approves the SAP and any significant modifications. Has authority to suspend project activities if Navy quality requirements are not met.	Naval Facilities Engineering Command, Southwest Division, San Diego, CA narciso.ancog@navy.mil (619) 532-2540
Greg Swanson	Tetra Tech	Program QA manager	Responsible for regular discussion and resolution of QA issues with Navy QA officer. Provides program-level QA guidance to the installation coordinator, project manager, and the Tetra Tech Teams. Reviews and approves SAPs. Identifies nonconformances through audits and other QA reviews. Recommends corrective actions.	Tetra Tech, San Diego, CA greg.swanson@ttemi.com (619) 525-7188
Ron Ohta	Tetra Tech	Project QA officer	Responsible for providing guidance to Tetra Tech Teams that are preparing SAPs. Verifies that data collection methods specified in the SAP comply with Navy and Tetra Tech Team requirements. Conducts laboratory evaluations and audits, as necessary.	Tetra Tech, Sacramento, CA ron.ohta@ttemi.com (916) 853-4506
Joanna Canepa	Tetra Tech	Installation coordinator	Responsible for ensuring that all Tetra Tech activities at this installation are carried out in accordance with current Navy requirements.	Tetra Tech, San Francisco, CA joanna.canepa@ttemi.com (415) 222-8362
John Bosche	Tetra Tech	Project manager	Responsible for implementing all activities specified in the delivery order. Supervises preparation of the SAP by the Tetra Tech Team. Monitors and directs field activities to ensure compliance with the SAP.	Tetra Tech, San Francisco, CA john.bosche@ttemi.com (415) 222-8295
To be determined[bef10]	Tetra Tech	Field team lead	Responsible for directing day-to-day field activities conducted by the Tetra Tech Team and subcontractor personnel and providing technical support for the project. Verifies that field sampling and measurement procedures follow the SAP. Provides the project manager with regular reports on status of field activities.	To be determined

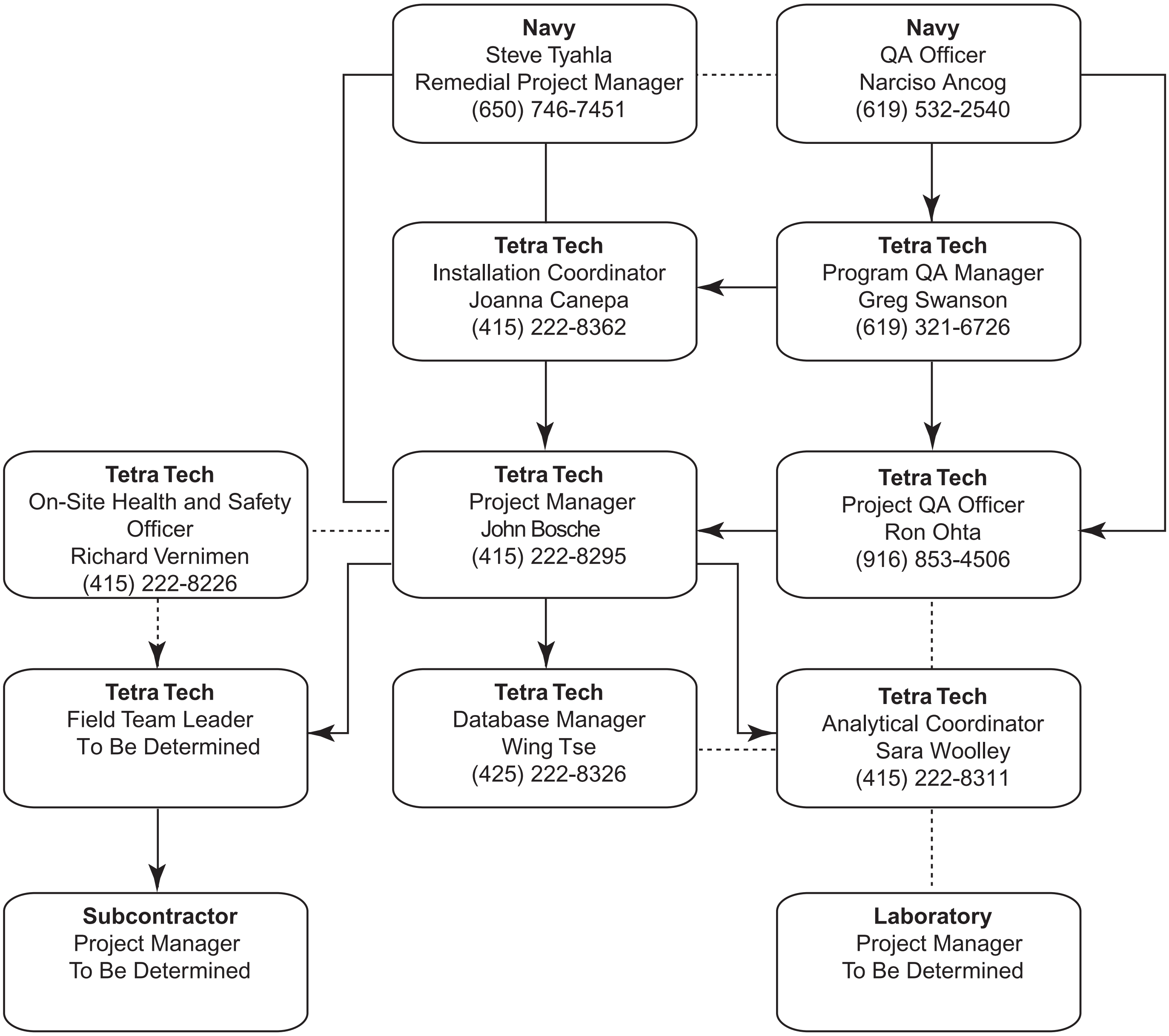
TABLE 6: KEY PERSONNEL (Continued)

Draft SAP, Additional Groundwater Investigation at Tidal Area Landfill, Site 1, Naval Weapons Station Seal Beach Detachment Concord, Concord, California

Name	Organization	Role	Responsibilities	Contact Information
To be determined[bef11]	Tetra Tech	On-site safety officer	Responsible for implementing the health and safety plan, determining appropriate site control measures, and identifying personal protection levels. Leads daily safety briefings for the Tetra Tech, subcontractor personnel, and site visitors. Has authority to suspend operations that threaten health and safety.	To be determined
Sara Woolley	Tetra Tech	Analytical coordinator	Responsible for working with the Tetra Tech Team to define analytical requirements. Assists in selection of a laboratory to complete required analyses (see Section 2.4 of SAP). Coordinates with the laboratory project manager on analytical requirements, delivery schedules, and logistics. Reviews laboratory data before they are released to the Tetra Tech Team.	Tetra Tech, San Francisco, CA sara.woolley@ttemi.com (415) 222-8304
Wing Tse	Tetra Tech	Database manager	Responsible for developing, monitoring, and maintaining project database under guidance of the project manager. Works with the project chemist to resolve sample identification issues during preparation of the SAP.	Tetra Tech, San Francisco, CA wing.tse@ttemi.com (415) 222-8326
To be determined	Laboratory	Project manager	Responsible for delivering analytical services that meet the requirements of the SAP. Reviews and understands all analytical requirements in the SAP. Works with the project chemist to confirm sample delivery schedules. Reviews the laboratory data package before it is delivered to the project chemist.	
To be determined	Subcontractor	Project manager	Responsible for ensuring that subcontractor activities are conducted in accordance with the requirements of the SAP. Coordinates subcontractor activities with the project manager or field team leader.	

Notes:

DQO Data quality objective
Navy U.S. Department of the Navy
QA Quality assurance
SAP Sampling and analysis plan
Tetra Tech Tetra Tech EM Inc.



Lines of Authority ———
Lines of Communication ---------

Notes:
Navy U.S. Department of the Navy
QA Quality Assurance

Tetra Tech EM Inc.

NAVAL WEAPONS STATION SEAL BEACH DETACHMENT
CONCORD, CALIFORNIA
EFA West, Daly City

FIGURE 6
PROJECT TEAM
ORGANIZATION CHART

Tidal Area Landfill
Additional Groundwater Investigation

Before work begins at a specific hazardous site, the following activities will be discussed and reviewed:

- Names of personnel and alternates responsible for health and safety at a hazardous waste project site
- Health and safety hazards present on site
- Selection of the appropriate personal protection levels
- Correct use of PPE
- Work practices to minimize risks from hazards
- Safe use of engineering controls and equipment on site
- Medical surveillance requirements, including recognition of symptoms and signs that might indicate overexposure to hazardous substances
- Contents of the site-specific health and safety plan (HASP)

1.5.2 Subcontractor Training

Subcontractors who work on site will certify that their employees have been trained for work on hazardous waste project sites. Training will meet OSHA requirements defined in 29 CFR Part 1910.120(e). Before work begins at the project site, subcontractors will submit copies of the training certification for each employee to Tetra Tech.

All employees of associate and professional services firms and technical services subcontractors will attend a safety briefing and complete the “Daily Tailgate Safety Meeting Form” (Appendix B) before they conduct on-site work. The topics described in Section 1.5.1 are covered in the briefing. The briefing is conducted by Tetra Tech’s on-site health and safety officer or other qualified person.

Subcontractors are responsible for conducting their own safety briefings. Tetra Tech personnel may audit these briefings.

1.6 Documents and Records

Documentation is critical for evaluating the success of any environmental data collection activity. This section discusses the requirements for documenting field activities and preparing laboratory data packages and describes reports that will be generated as a result of this project.

1.6.1 Field Documentation

Complete and accurate documentation is essential to demonstrate that field measurements and sampling procedures are carried out as described in the SAP. Field personnel will use permanently bound field logbooks with sequentially numbered pages to record and document field activities. The logbook will list the contract name and number, the job number, the site name, the names of subcontractors, the service client, and the project manager. At a minimum, the following information will be recorded in the field logbook:

- Name and affiliation of all on-site personnel or visitors
- Weather conditions during the field activity
- Summary of daily activities and significant events
- Notes of conversations with coordinating officials
- References to the field logbooks or forms that contain specific information
- Discussions of problems encountered and their resolution
- Discussions of deviations from the SAP or other governing documents
- Description of all photographs taken
- List of equipment models used and calibration results
- Sample collection information

All information will be entered using a ballpoint pen with waterproof ink. Every line of the logbook will be used. If a subject changes and an additional blank space is necessary to make the new subject stand out, one line will be skipped before the new subject begins. A new page will begin each day's notes, and a diagonal line will be drawn on any blank spaces of four lines or more to prevent unauthorized entries. A single line will be drawn through the entry, and the line will be initialed and dated, to make corrections in the logbook.

The field team will also use the field forms presented in Appendix B.

1.6.2 Summary Data Package

The subcontracted laboratory will prepare summary data packages in accordance with the instructions provided in the EPA Contract Laboratory Program (CLP) statements of work (SOWs) (EPA 1999a, 2000a). The summary data package will consist of a case narrative, copies of all associated chain-of-custody (COC) forms, sample results, and quality assurance (QA) and QC summaries. The case narrative will include the following information:

- Subcontractor name, project name, job number, project order number, sample delivery group (SDG) number, and a table that cross-references client and laboratory sample identification (ID) numbers

- Detailed documentation of all sample shipping and receiving, preparation, analytical, and quality deficiencies

- Thorough explanation of all instances of manual integration

- Copies of all associated nonconformance and corrective action forms that will describe the nature of the deficiency and the corrective action taken

- Copies of all associated sample receipt notices

1.6.3 Full Data Package

A full data package, when required, will be prepared in accordance with the instructions provided in the EPA CLP SOWs (EPA 1999a, 2000a). Full data packages will contain all of the information from the summary data package and all associated raw data. Table 7 outlines the requirements for the full data package. Full data packages are due to Tetra Tech within 21 days after the laboratory receives the last sample in the SDG. Unless otherwise requested, the subcontractor will deliver one copy of the full data package.

1.6.4 Data Package Format

The subcontracted laboratory will provide electronic data deliverables (EDD) for all analytical results. An automated laboratory information management system (LIMS) must be used to produce the EDDs. Manual creation of the deliverable (data entry by hand) is unacceptable. The laboratory will verify EDDs internally before they are issued. The EDDs will correspond exactly to the hard-copy data. No duplicate data will be submitted. EDDs will be delivered in a format compatible with the Navy Environmental Data Transfer Standards (NEDTS). Results that should be included in all EDDs are as follows:

- Target analyte results for each sample and the associated analytical methods that were requested on the chain-of-custody form

- Method and instrument blank and preparation and calibration blank results reported for the SDG

- Percent recoveries for the spike compounds in the MSs, MSDs, blank spikes, and LCSs, as applicable

- Matrix duplicate results reported for the SDG

- All reanalysis, re-extractions, or dilutions reported for the SDG, including those associated with samples and the specified laboratory QC samples

Electronic and hard-copy data must be retained for a minimum of 3 and 10 years, respectively, after final data have been submitted. The subcontractor will use an electronic storage device capable of recording data for long-term, off-line storage. Raw data will be retained in an electronic data archival system.

TABLE 7: REQUIREMENTS FOR SUMMARY AND FULL DATA PACKAGES

Draft SAP, Additional Groundwater Investigation at Tidal Area Landfill, Site 1, Naval Weapons Station Seal Beach Detachment Concord, Concord, California

Requirements for Summary Data Packages – Organic Analysis		Requirements for Summary Data Packages – Inorganic Analysis	
Section I	Case Narrative	**Section I**	Case Narrative
1.	Case narrative	1.	Case narrative
2.	Copies of nonconformance and corrective action forms	2.	Copies of nonconformance and corrective action forms
3.	Chain-of-custody forms	3.	Chain-of-custody forms
4.	Copies of sample receipt notices	4.	Copies of sample receipt notices
5.	Internal tracking documents, as applicable	5.	Internal tracking documents, as applicable
Section II	Sample Results - Form I for the following:	**Section II**	Sample Results - Form I for the following:
1.	Environmental samples, including dilutions and re-analysis	1.	Environmental sample including dilutions and re-analysis
2.	TICs (VOCs and SVOCs only)		
Section III	QA/QC Summaries - Forms II through XI for the following:	**Section III**	QA/QC Summaries - Forms II through XIV for the following:
1.	System monitoring compound and surrogate recoveries (Form II)	1.	Initial and continuing calibration verifications (Form II)
2.	MS and MSD recoveries and RPDs (Forms I and III)	2.	PRRL standard (Form II)
3.	Blank spike or LCS recoveries (Forms I and III-Z)	3.	Detection limit standard (Form II-Z)
4.	Method blanks (Forms I and IV)	4.	Method blanks, continuing calibration blanks, and preparation blanks (Form III)
5.	Performance check (Form V)	5.	ICP interference-check samples (Form IV)
6.	Initial calibrations with retention time information (Form VI)	6.	MS and post-digestion spikes (Forms V and V-Z)
7.	Continuing calibrations with retention time information (Form VII)	7.	Sample duplicates (Form VI)
8.	Quantitation limit standard (Form VII-Z)	8.	LCSs (Form VII)
9.	Internal standard areas and retention times (Form VIII)	9.	Method of standard additions (Form VIII)
10.	Analytical sequence (Forms VIII-D and VIII-Z)	10.	ICP serial dilution (Form IX)
11.	GPC calibration (Form IX)	11.	IDL (Form X)
12.	Single component analyte identification (Form X)	12.	ICP interelement correction factors (Form XI)
13.	Multicomponent analyte identification (Form X-Z)	13.	ICP linear working range (Form XII)
14.	Matrix-specific method detection limit (MDL) (Form XI-Z)		
Sections I, II, and III	Summary Package	**Sections I, II, III**	Summary Package
Section IV	Sample Raw Data - indicated form, plus all raw data	**Section IV**	Instrument Raw Data - Sequential measurement readout records for ICP, graphite furnace atomic absorption, flame atomic absorption, cold vapor mercury, cyanide, and other inorganic analyses, which will contain the following information:
1.	Analytical results, including dilutions and reanalysis (Forms I and X)	1.	Environmental samples, including dilutions and reanalysis
2.	TICs (Form I — VOCs and SVOCs only)	2.	Initial calibration

TABLE 7: REQUIREMENTS FOR SUMMARY AND FULL DATA PACKAGES (Continued)

Draft SAP, Additional Groundwater Investigation at Tidal Area Landfill, Site 1, Naval Weapons Station Seal Beach Detachment Concord, Concord, California

Requirements for Summary Data Packages – Organic Analysis	Requirements for Summary Data Packages – Inorganic Analysis
Section V QC Raw Data - indicated form, plus all raw data	**Section IV (Continued)** Instrument Raw Data - Sequential measurement readout records for ICP, graphite furnace atomic absorption, flame atomic absorption, cold vapor mercury, cyanide, and other inorganic analyses, which will contain the following information:
1. Method blanks (Form I)	3. Initial and continuing calibration verifications
2. MS and MSD samples (Form I)	4. Detection limit standards
3. Blank spikes or LCSs (Form I)	5. Method blanks, continuing calibration blanks, and preparation blanks
	6. ICP interference check samples
Section VI Standard Raw Data - indicated form, plus all raw data	7. MS and post-digestion spikes
1. Performance check (Form V)	8. Sample duplicates
2. Initial calibrations, with retention-time information (Form VI)	9. LCSs
3. Continuing calibrations, with retention-time information (Form VII)	10. Method of standard additions
4. Quantitation-limit standard (Form VII-Z)	11. ICP serial dilution
5. GPC calibration (Form IX)	
Section VII **Other Raw Data**	**Section V** Other Raw Data
1. Percent moisture for soil samples	1. Percent moisture for soil samples
2. Sample extraction and cleanup logs	2. Sample digestion, distillation, and preparation logs, as necessary
3. Instrument analysis log for each instrument used (Form VIII-Z)	3. Instrument analysis log for each instrument used
4. Standard preparation logs, including initial and final concentrations for each standard used	4. Standard preparation logs, including initial and final concentrations for each standard used
5. Formula and a sample calculation for the initial calibration	5. Formula and a sample calculation for the initial calibration
6. Formula and a sample calculation for soil sample results	6. Formula and a sample calculation for soil sample results

Notes:

GPC	Gel permeation chromatography	QA/QC	Quality assurance/quality control
IDL	Instrument detection limit	RPD	Relative percent difference
ICP	Inductively coupled plasma	SAP	Sampling and analysis plan
LCS	Laboratory control sample	SVOC	Semivolatile organic compound
MS	Matrix spike	TIC	Tentatively identified compound
MSD	Matrix spike duplicate	VOC	Volatile organic compound
PRRL	Project-required reporting limits		

1.6.5 Reports Generated

The groundwater data collected during this investigation will be used in conjunction with the information gathered previously and will be used to prepare a draft study of groundwater for Site 1.

2.0 DATA GENERATION AND ACQUISITION

This section describes the requirements for the following data generation and acquisition activities:

- Sampling Process Design (Section 2.1)
- Sampling Methods (Section 2.2)
- Sample Handling and Custody (Section 2.3)
- Analytical Methods (Section 2.4)
- Quality Control (Section 2.5)
- Equipment Testing, Inspection, and Maintenance (Section 2.6)
- Instrument Calibration and Frequency (Section 2.7)
- Inspection and Acceptance of Supplies and Consumables (Section 2.8)
- Nondirect Measurements (Section 2.9)
- Data Management (Section 2.10)

2.1 SAMPLING PROCESS DESIGN

The Navy will install five additional monitoring wells and collect groundwater samples during this field investigation to obtain the data needed to meet the objectives listed in Section 1.3. This investigation will specifically include the following tasks:

- Conduct surveys for unexploded ordnance (UXO) and underground utilities before locations for wells are selected
- Install and develop five monitoring wells
- Survey the five newly installed wells and measure water levels in newly installed and existing wells and piezometers
- Collect and analyze groundwater samples from five newly installed monitoring wells, seven existing monitoring wells, and three existing piezometers.

Proposed locations for groundwater monitoring wells are shown on Figure 2. The rationale for the selection of the proposed well locations is discussed in the following section.

2.2 FIELD METHODS

This section discusses the field methods that will be used during this investigation. The individual tasks are organized and described in this section as follows:

- UXO and Utility Clearance (Section 2.2.1)
- Monitoring Well Installation and Development (Section 2.2.2)
- Land Surveying (Section 2.2.3)
- Groundwater Sampling Methods (Section 2.2.4)
- Aquifer Testing (Section 2.2.5)

2.2.1 UXO and Utility Clearance

All locations will be cleared for UXO and underground utilities before field work is conducted. Proposed locations for well installation will be cleared for UXO with a surface sweep on an appropriate grid using a Schoensted magnetometer and an EM61 magnetometer. Locations will also be cleared for underground utilities before any intrusive work begins, and Underground Services Alert will be contacted within 72 hours after field work begins.

2.2.2 Monitoring Well Installation and Development

A total of five monitoring wells will be installed near the perimeter of the Tidal Area Landfill to address potential data gaps in evaluating potential contaminant migration in groundwater from the landfill. The proposed rationales, samples, and analytical suite for the five wells are discussed on Tables 8 and 9. The five additional wells will supplement the existing network of seven monitoring wells and six piezometers. The five proposed monitoring wells include the following (Figure 2):

- Two additional wells along the western perimeter of the landfill to supplement the existing network of monitoring wells and monitor potential contaminant migration to the west (TLSMW008 and TLSMW009).
- One additional monitoring well at the northern perimeter of the landfill to supplement the existing network of monitoring wells and monitor potential contaminant migration to the north (TLSMW012).
- Two additional monitoring wells along the southern perimeter of the landfill to monitor potential contaminant migration through coarser-grained channel fill soils that could act as a preferential pathway (TLSMW010 and TLSMW011).

TABLE 8: PROPOSED SAMPLES, RATIONALE, AND ANALYSES – FIRST QUARTER SAMPLING EVENT

Draft SAP, Additional Groundwater Investigation at Tidal Area Landfill, Site 1,
Naval Weapons Station Seal Beach Detachment Concord, Concord, California

Location Name	Sample ID Number	Analyses	Existing or Proposed Well or Piezometer	Rationale
TLSMW001	032TL01GW001	Target Analyte List (TAL) Metals[RTO15] Hexavalent chromium Mercury VOCs SVOCs (including n-nitrosodimethylamine) Pesticides Explosives Perchlorate TPH-extractables TPH-purgeables 1,4-dioxane 1,2,3-trichloropropane Total dissolved solids Total suspended solids General anions	Existing	Ongoing evaluation of off-site groundwater impacts from landfill.
TLSMW002	032TL02GW002		Existing	Ongoing evaluation of off-site groundwater impacts from landfill.
TLSMW003	032TL03GW003		Existing	Ongoing evaluation of off-site groundwater impacts from landfill.
TLSMW004	032TL04GW004		Existing	Ongoing evaluation of off-site groundwater impacts from landfill.
TLSMW005	032TL05GW005		Existing	Ongoing evaluation of off-site groundwater impacts from landfill.
TLSMW006	032TL06GW006		Existing	Ongoing evaluation of off-site groundwater impacts from landfill.
TLSMW007	032TL07GW007		Existing	Ongoing evaluation of offsite groundwater impacts from landfill.-
RADPZ003	032TL08GW008		Existing	Sample from sand unit east of landfill (sand unit is approximately 18 to 21 feet bgs).
RADPZ004	032TL09GW009		Existing	Sample from sand unit east of landfill (sand unit is approximately 16 to 19.5 feet bgs).
RADPZ006	032TLP6GW010		Existing	Sample from sandy silt unit at eastern landfill perimeter (sandy silt unit is approximately 20 to 21.5 feet bgs).
TLSMW008	032TL08GW011		Proposed	Samples from shallow groundwater at northwest perimeter of landfill.
TLSMW009	032TL09GW012		Proposed	Samples from shallow groundwater at western perimeter of landfill.
TLSMW010	032TL10GW013		Proposed	Samples from shallow groundwater within former drainage feature.
TLSMW011	032TL11GW014		Proposed	Samples from shallow groundwater within former drainage feature.
TLSMW012	032TL12GW015		Proposed	Samples from shallow groundwater at northern perimeter of landfill.

TABLE 8: PROPOSED SAMPLES, RATIONALE, AND ANALYSES (Continued)

Internal Draft SAP, Additional Groundwater Investigation at Tidal Area Landfill, Site 1,
Naval Weapons Station Seal Beach Detachment Concord, Concord, California

Location Name	Sample ID Number	Analyses	Existing or Proposed Well or Piezometer	Rationale
Field Duplicate	032TLXXGW016		TBD	Assess precision of field sampling.
Field Duplicate	032TLXXGW017		TBD	Assess precision of field sampling.
Equipment Rinsate	032TL00GW018		NA	Assess adequacy of equipment decontamination.
Equipment Rinsate	032TL00GW019		NA	Assess adequacy of equipment decontamination.
Trip Blank	032TL00GW020		NA	Assess potential contamination during transport.
Source Water Blank	032TL00GW021		NA	Assess purity of water to be used for decontamination.

Notes:

bgs Below ground surface
NA Not applicable
SVOC Semivolatile organic compound
TBD To be determined in the field
TPH Total petroleum hydrocarbon. Includes TPH-purgeable (TPH-p) and TPH-extractable (TPH-e)
VOC Volatile organic compound

TABLE 9: PROPOSED SAMPLES, RATIONALE, AND ANALYSES - SECOND THROUGH FOURTH QUARTER SAMPLING EVENTS

Draft SAP, Additional Groundwater Investigation at Tidal Area Landfill, Site 1,
Naval Weapons Station Seal Beach Detachment Concord, Concord, California

Location Name	Sample ID Number	Analyses	Existing or Proposed Well or Piezometer	Rationale
TLSMW008	032TL08GWXXX	Metals Mercury VOCs SVOCs (including n-nitrosodimethylamine) Perchlorate TPH-extractables TPH-purgeables 1,2,3-trichloropropane Total dissolved solids Total suspended solids General anions Samples will be analyzed for hexavalent chromium, explosives, pesticides, and 1,4-dioxane during the second- through fourth-quarter sampling events only if the compounds are detected during the first-quarter sampling event.	Proposed	Samples from shallow groundwater at northwest perimeter of landfill.
TLSMW009	032TL09GWXXX		Proposed	Samples from shallow groundwater at western perimeter of landfill.
TLSMW010	032TL10GWXXX		Proposed	Samples from shallow groundwater within former drainage feature.
TLSMW011	032TL11GWXXX		Proposed	Samples from shallow groundwater within former drainage feature.
TLSMW012	032TL12GWXXX		Proposed	Samples from shallow groundwater at northern perimeter of landfill
Field Duplicate	032TLXXGWXXX		TBD	Assess field sampling precision.
Equipment Rinsate	032TL00GWXXX		NA	Assess adequacy of equipment decontamination.
Trip Blank[a]	032TL00GWXXX		NA	Assess potential contamination during transport.
Source Water Blank	032TL00GWXXX		NA	Assess purity of water source.

Notes: Sample IDs will be assigned in the field to sequentially follow the sampling IDs assigned during the previous quarter.

a Trip blanks will be analyzed for VOCs and TPH-purgeables only.

bgs Below ground surface
NA Not applicable
SVOC Semivolatile organic compound
TBD To be determined in the field
TPH Total petroleum hydrocarbon. Includes TPH-purgeable (TPH-p) and TPH-extractable (TPH-e)
VOC Volatile organic compound

Soil samples will be collected continuously at each proposed well location for logging to the total depth of the well. Monitoring wells TLSMW010 and TLSMW011 are to be installed within the former channel of Otter Sluice. The shallow soils in the borings for these wells will be examined for evidence to confirm that the proposed location is within the former channel. If the shallow soils examined consist entirely of fine-grained soils, additional borings will be drilled nearby along the perimeter of the landfill to help locate the position of the former channel.

The method to be used for well installation will depend on conditions when the well is installed. The wells will be installed using hollow-stem auger drilling methods, as described in Section 2.2.2.1, if the proposed locations are not covered by water and can be accessed by a drilling rig mounted on an all-terrain vehicle. The wells will be installed using a hand auger, as described in Section 2.2.2.2, if the well locations are covered by water or cannot be accessed by a drilling rig mounted on an all-terrain vehicle.

2.2.2.1 Monitoring Well Installation Using Hollow-stem Auger Drilling Methods

If each of the well locations can be accessed by a drilling rig mounted on an all-terrain vehicle, the wells will be installed using hollow-stem auger drilling methods, in accordance with the procedures described in Tetra Tech SOP No. 020, Revision No. 3, “Monitoring Well Installation” (Appendix B). The boreholes will be drilled with 10- to 12-inch diameter continuous flight hollow-stem augers. Soil samples will be collected continuously and logged from ground surface to the total depth of the well. Monitoring wells will be constructed of 4-inch diameter, schedule 40 polyvinyl chloride (PVC) with threaded, flush-jointed riser pipes. Ten-foot-long well screens will extend from the riser pipes with No. 10 (0.01-inch) slots. The top of the well screens will be placed at the lower depth of: (1) approximately 1 foot above the highest predicted elevation of the water table, or (2) a minimum of 2 feet bgs. A contractor licensed by the State of California will install the proposed wells. All equipment decontamination fluids and soil cuttings from drilling will be containerized in sealed 55-gallon drums and handled as described in Section 2.2.4.4.

The sand pack for the monitoring well will be poured through the drive casing from approximately 1 foot below the bottom of the well screen to an elevation approximately 6 inches to 1 foot above the well screen. Filter packs will consist of clean quartz sand. The drive casing will be removed slowly from the borehole as the sand pack is poured around the screen to ensure that no gaps or bridging occur. The top of the sand pack will be measured frequently with a weighted tape during placement to ensure that the bottom of the drive casing is not above the top of the sand pack. Before the bentonite seal is placed, the filter pack will be carefully re-measured to ensure that it has been installed correctly. A 1-foot filter collar of bentonite pellets will be installed directly on top of the filter pack, and the remainder of the annular space will be filled with cement-bentonite grout. Wells will be completed above ground surface. A minimum of 24 hours after the grout has been poured, wells will be covered with a stove pipe and bumper posts to prevent the wells from being damaged.

2.2.2.2 Well Installation Methods for Restricted Access Conditions

If the well locations are covered by water or are not accessible by a drilling rig mounted on an all-terrain vehicle, the wells will be installed using a hand auger. If surface water is present, a temporary berm will be placed around the well location to enable the field crew to remove the surface water during well installation. The boreholes will be advanced using a hand auger with a minimum 3-inch diameter. Soil samples will be collected continuously and logged from ground surface to the total depth of the well. Monitoring wells will be constructed of a 1-inch inside diameter, schedule 40 PVC with threaded, flush-jointed riser pipes. Ten-foot-long, pre-pack well screens will extend from the riser pipes with No. 10 (0.01-inch) slots. The top of the well screens will be placed at the lower depth of: (1) approximately 1 foot above the highest predicted elevation of the water table, or (2) a minimum of 2 feet bgs.

Sand will be placed in the pre-pack well screen at the surface before it is inserted in the boring. The outer sand pack will be poured through the drive casing from approximately 1 foot below the bottom of the well screen to an elevation approximately 6 inches to 1 foot above the well screen. Filter packs will consist of clean quartz sand. The drive casing will be removed slowly from the borehole as the sand pack is poured around the screen to ensure that no gaps or bridging occur. The top of the sand pack will be measured frequently with a weighted tape during placement to ensure that the bottom of the drive casing is not above the top of the sand pack. Before the bentonite seal is placed, the filter pack will be carefully re-measured to ensure that it has been installed correctly. A 1-foot filter collar of bentonite pellets will be installed directly on top of the filter pack, and the remainder of the annular space will be filled with cement-bentonite grout. Wells will be completed above ground surface. A minimum of 24 hours after the grout has been poured, wells will be covered with a stove pipe and bumper posts to prevent the wells from being damaged.

2.2.2.3 Well Development

After construction, each monitoring well will be developed to maximize yield and minimize turbidity of the water. Wells will be developed in accordance with Tetra Tech SOP No. 021, Revision No. 3, “Monitoring Well Development” (Appendix B). Wells will be developed with a surge block and pump technique until the well yields clear water that is free of turbidity and suspended solids, or until in the opinion of Tetra Tech’s field geologist, further development will not significantly improve the clarity of the water. All purge water from well development will be containerized and transported to the central storage area for IDW.

2.2.3 Land Surveying

After the monitoring wells are completed, a professional land surveyor licensed by the State of California will provide the elevation of each location relative to mean sea level (msl), based on the National Geodetic Vertical Datum of 1929 and its horizontal position in California State Plane Coordinates, relative to the North American readjustment of 1927. Existing monitoring well BUAMW002 will also be surveyed to provide a top of casing elevation that is not currently available. All elevations and coordinates will be measured in U.S. survey feet to the nearest 0.1 foot. The survey data will be merged with existing survey data in the installation database. Vertical coordinates will be reported as feet above msl.

2.2.4 Groundwater Sampling Methods

Groundwater samples sampling will be collected quarterly for four consecutive quarters at the five new wells and once at the seven existing monitoring wells and three existing piezometers[RTO16]. Figure 2 shows the locations of the proposed and existing monitoring wells. Table 8 summarizes the analytical program during the first quarter of sampling. Table 9 summarizes the analytical program during the second through fourth quarters of sampling.

Water levels will be measured at each well before each sampling event begins. Corrected groundwater elevation data will be used to estimate the direction of groundwater flow. Only groundwater elevations measured within similar hydrogeologic units will be compared to estimate the direction of groundwater flow.

This section describes the procedures for groundwater sample collection, including low-flow sampling and purging methods; alternative purging methods; equipment decontamination; management of IDW; and sample containers, preservation, and holding times.

2.2.4.1 Low-Flow Sampling and Purging Methods

Low flow-rate purging techniques will be used, where technically feasible, to obtain groundwater samples from wells. Low flow-rate purging will be considered technically infeasible if the water level is below 25 feet bgs or if the well is unable to support a recharge rate of 0.1 liter per minute (L/min), as described in the following text. A principal objective of low flow-rate purging is to avoid entraining silt- and clay-sized particles in groundwater samples by purging wells at low velocities. Low-velocity purging is intended to establish direct flow from the aquifer to the sample container at velocities and flow conditions comparable to in situ flow velocities. By using low flow-rate purging techniques, the sampling process more closely matches natural groundwater flow conditions, and transport of suspended solids, and analytical problems and uncertainties caused by turbidity are reduced. The field procedure for low flow-rate sampling techniques is described as follows:

1. The breathing zone will be monitored with a photoionization detector while each well cap is removed, and the reading will be compared with the background reading for the site to select the appropriate level of personal protection.
2. The depth to water will be measured with an electric-sounder water level meter to establish the equilibrium water level.
3. The pump intake will be gently lowered into the well to a depth of 3.5 feet below the equilibrium water level or 2 feet below the top of the well screen (whichever is greater) and secured to the outer well casing with tape or plastic ties.

4. Well purging will be initiated slowly and increased gradually to a rate of approximately 0.15 L/min using a peristaltic pump. Stabilization parameters for the purge water, including pH, temperature, electrical conductivity, dissolved oxygen, and turbidity, will be measured at intervals of a minimum of 1 liter (L) and recorded on well sampling sheets or in field notebooks. Purge water will be discharged into a graduated cylinder, and the volume of water purged will also be measured and recorded on well sampling sheets. If the drawdown of the water level is 0.3 foot or greater at that pumping rate, procedures 5 and 6 will be initiated. If the drawdown in the water level is less than 0.3 foot at that pumping rate and the water level is stable, the flow will be increased to the maximum rate where a static water level is obtained (up to 0.5 L/min), and procedures 7 and 8 will be initiated.

5. When drawdown is more than 0.3 foot at a rate of 0.15 L/min, a modified low-flow purge protocol will be attempted. Using the modified low-flow purge protocol, the pump rate will be increased to a maximum of 1 L/min, and the water level will be drawn down to 1.5 to 3 feet from the equilibrium water level.

6. The pumping rate will then be adjusted within the range of 0.1 to 0.5 L/min until the water level in the well is stable and the recharge rate matches the discharge rate. If the water level continues to decrease at a pumping rate of 0.1 L/min, low flow-rate purging will be considered technically unfeasible, and the well will be purged by the alternative technique described in the following text.

7. The purge water will be considered stabilized after a minimum of eight measurements have been collected (8 L purged) and three successive measurements of each of the stabilization parameters fall within the following ranges:

pH:	± 0.1
Electrical conductivity:	± 3 percent microSiemens per centimeter
Temperature:	± 0.5 °C
Dissolved oxygen:	± 0.2 milligram per L
Turbidity:	± 15 percent relative percent difference or three successive measurements of less than 15 nephelometric turbidity units

8. Well stabilization parameters will be expected to asymptotically approach a constant value as the purge water begins to stabilize. If well stabilization parameters are within the ranges specified previously but still appear to be approaching an asymptotic value, well purging will be continued until the purge water appears to be at equilibrium or until a maximum of 20 L has been purged from the well.

Well stabilization parameters, including temperature, pH, electrical conductivity, dissolved oxygen, and turbidity, will be measured immediately before sampling and recorded on well sampling sheets or in field notebooks.

The following procedures will be followed in collecting groundwater samples from monitoring wells after purging has been completed:

1. Measuring and sampling equipment will be decontaminated before samples are collected from each location.
2. When the low flow-rate purging techniques are used or if samples can be collected with a peristaltic pump, water samples will be collected directly from the discharge of the peristaltic pump. If samples cannot be collected with a peristaltic pump, disposable bailers will be used.
3. The bottles for analysis of VOCs will be filled first, followed by the bottles for TPH-purgeables, TPH-extractables, explosives, SVOCs, pesticides, hexavalent chromium, perchlorate, metals, mercury, total dissolved solids, total suspended solids, and general anions.

2.2.4.2 Alternative Purging Methods

In cases where recharge rates in the formation will not allow low flow-rate purging, the wells will be purged dry, allowed to recharge overnight, and sampled the next day, as described in the following list:

1. All water will be purged from the well with a peristaltic pump.
2. The well will be allowed to recharge and will be sampled with a peristaltic pump after the well has recovered to within 80 percent of the initial water level, but not later than 24 hours after it is purged.

2.2.4.3 Equipment Decontamination

To prevent cross-contamination, reusable measuring and sampling equipment will be decontaminated before sample collection begins and between each well. All nondisposable groundwater sampling equipment will be decontaminated in accordance with the procedures specified in Tetra Tech SOP No. 002, Revision No. 2, "General Equipment Decontamination," as applicable (Appendix B). Electric-sounder water level meters and pumps used during groundwater sampling will be decontaminated before each use by washing the probe and the portion of the cable directly above the probe with distilled water and wiping the parts clean with a disposable paper towel. Decontamination fluids will be placed in containers and handled in accordance with the procedures specified below.

2.2.4.4 Management of Investigation-Derived Waste

Minimal quantities of IDW are expected during this investigation, but will include soil cuttings, purge water, decontamination water, and debris such as used personal protective gear, tubing, and general trash. IDW will be placed in 55-gallon drums approved by the U.S. Department of Transportation and will be labeled with information about their contents, the source of their contents, the generation date, and the Navy point of contact. Drums will be left on site pending characterization and disposal of the contents by Tetra Tech.

2.2.4.5 *Sample Containers, Preservation, and Holding Times*

Table 10 presents the type of sample containers to be used for each analysis, the sample volumes required, the preservation requirements, and the maximum holding times for samples before extraction and analysis.

2.2.5 Aquifer Testing

Aquifer tests will be conducted at existing monitoring well TLMW004 and existing piezometer RADPZ006. Aquifer tests will also be conducted at each of the proposed additional monitoring wells with an inside diameter of 2 inches or larger. The aquifer test will consist of slug withdrawal testing or "rising head" tests. A slug of known volume will be withdrawn from the well, and water levels will be monitored during recovery. Water levels will be monitored using an electronic transducer capable of rapidly collecting and storing water level measurements.

The water level data will be analyzed using the commercially available program, AQTESOLV, and the methods of Bouwer and Rice (1976) for unconfined aquifers.

2.3 SAMPLE HANDLING AND CUSTODY

This section describes sample handling procedures, including sample identification, labeling, and documentation; COC records; and shipping procedures.

2.3.1 Sample Identification

A unique sample ID number will be assigned to each sample collected during this project. The sample ID numbering system is designed to be compatible with a computerized data management system that includes previous results for samples collected at NWSSBD Concord. The sample numbering system allows each sample to be uniquely identified and provides a means of tracking the sample from collection through analysis. The numbering system indicates the contract number, the site name, the sampling type, and the sequential sample number. The numbering scheme is illustrated below.

Tetra Tech Delivery Order	032
Site	TL = Tidal Area Landfill
Well Identification	01
Sample Type	GW = Groundwater sample
Sample Number	001 = Sample numbers will be sequential

TABLE 10: SAMPLE CONTAINER, PRESERVATIVE, AND HOLDING TIME REQUIREMENTS

Draft SAP, Additional Groundwater Investigation at Tidal Area Landfill, Site 1,
Naval Weapons Station Seal Beach Detachment Concord, Concord, California

Parameter	Method Number	Sample Volume	Sample Container	Preservative	Holding Time[a]
TPH-Extractables (diesel- and motor oil-range organics)	EPA 8015B, SW-846	Two 1-L	Amber glass with Teflon-lined lid	Cool 4 ± 2ºC	7 days/40 days
TPH-Purgeables (gasoline-range organics)	EPA 8015B, SW-846	Three 40-mL	Amber glass vials with Teflon-lined lid	pH < 2 with HNO_3; Cool 4 ± 2ºC	14 days
Metals (except mercury)	EPA 6010B, SW-846	1-L	Polyethylene	pH < 2 with HNO_3; Cool 4 ± 2ºC	6 months
Mercury	EPA 1631[RTO17]	100-mL	Polyethylene	pH < 2 with HNO_3; Cool 4 ± 2ºC	28 days
Hexavalent chromium	EPA 7196A, SW-846	500-mL	Polyethylene	Cool 4 ± 2ºC	24 hours
VOCs	EPA 8260B, SW-846	Three 40-mL	Amber glass vials with Teflon-lined lid	pH < 2 with HCL; Cool 4 ± 2ºC	14 days
SVOCs	EPA 8270C, SW-846	Two 1-L	Amber glass with Teflon-lined lid	Cool 4 ± 2ºC	7 days/40 days
Pesticides	EPA 8081A, SW-846	Two 1-L	Amber glass with Teflon-lined lid	Cool 4 ± 2ºC	7 days/40 days
Explosives	EPA 8330, SW-846	Two 1-L	Amber glass with Teflon-lined lid	Cool 4 ± 2ºC	7 days/40 days
Perchlorate[b]	EPA 314.0	Three 40-mL	Amber glass vials with Teflon-lined lid	Cool 4 ± 2ºC	28 days
Perchlorate[b]	EPA 8321A, SW-846 modified to include LC/MS/MS	250-mL	Glass or Polyethylene	Cool 4 ± 2ºC	28 days
Total dissolved solids	EPA 160.1	One 1-L	Glass or Polyethylene	Cool 4 ± 2ºC	7 days
Total suspended solids	EPA 160.2	One 1-L	Glass or Polyethylene	Cool 4 ± 2ºC	7 days
General anions	EPA 300.1	Two 500-mL	Polyethylene	Cool 4 ± 2ºC	28 days

TABLE 10: SAMPLE CONTAINER, PRESERVATIVE, AND HOLDING TIME REQUIREMENTS (Continued)
Draft SAP, Additional Groundwater Investigation at Tidal Area Landfill, Site 1,
Naval Weapons Station Seal Beach Detachment Concord, Concord, California

Notes:	More than one analysis can be obtained from the same sample container. The sample quantities listed in the table are the amounts necessary if only the specific analysis is requested. The laboratory will indicate which of the analyses can be performed from the same container so that a smaller quantity of sample can be collected at each depth.
	Analyses for characterization of investigation-derived waste (IDW) samples are included in the table.
a	"x" days/"y" days refers to the maximum number of days from sampling to extraction/the maximum number of days from extraction to analysis
b	All samples will be analyzed by both Method 314.0 and Method 8321M (LC/MS/MS).

EPA	U.S. Environmental Protection Agency	MS/MSD	Matrix spike/matrix spike duplicate
HCL	Hydrochloric acid	PAH	Polynuclear aromatic hydrocarbon
HNO_3	Nitric acid	SVOC	Semivolatile organic compound
L	Liter	TPH	Total petroleum hydrocarbon
mL	Milliliter	VOC	Volatile organic compound

For example, the first groundwater sample collected during this investigation will be identified as 032TL01GW001, and the second sample will be identified as 032TL01GW002. Sample numbers will continue consecutively for the four quarters of sampling. Field QC samples for this investigation include duplicate samples, equipment rinsate blanks, and source water blanks. The same sample ID nomenclature will be used for these QC samples to ensure that they are blind when received by the laboratories. Tables 8 and 9 list the sample ID numbers for this investigation.

2.3.2 Sample Labels

A sample label will be affixed to all sample containers. The label will be completed with the following information written in indelible ink:

- Project name and location
- Sample ID number
- Date and time of sample collection
- Preservative used
- Sample collector's initials
- Analysis required

After each sample is labeled, it will be refrigerated or placed in a cooler that contains ice to maintain the sample temperature at 4 °C, plus or minus 2 °C.

2.3.3 Sample Documentation

Sample documentation is important to ensure proper identification of the samples. Field personnel will use the following guidelines for maintaining field documentation:

- Documentation will be completed in permanent black ink
- All entries will be legible
- Errors will be crossed out with a single line, and the lineout will be dated and initialed
- Serialized documents will be maintained by Tetra Tech and referenced in the site logbook
- Unused portions of pages will be crossed out, and each page will be signed and dated

2.3.4 Chain-of-Custody Procedures

Field personnel will use standard sample custody procedures to maintain and document sample integrity during collection, transportation, storage, and analysis. A sample will be considered to be in custody if one of the following statements applies:

- It is in a person's physical possession or view.
- It is in a secure area with restricted access.
- It is placed in a container and secured with an official seal so the sample cannot be reached without breaking the seal.

COC procedures provide an accurate written record that traces the possession of individual samples from the time they are collected in the field to the time they are accepted at the laboratory. The COC form (Appendix B) will be used to document all samples collected and the analysis requested for each sample. Field personnel will record the following information on the COC form:

- Project name and number
- Sampling location
- Name and signature of sampler
- Destination of samples (laboratory name)
- Sample ID number
- Date and time of collection
- Number and type of containers filled
- Analysis requested
- Preservatives used (if applicable)
- Filtering (if applicable)
- Sample designation (grab or composite)
- Signatures of individuals involved in custody transfer, including the date and time of transfer
- Airbill number (if applicable)
- Project contact and phone number

Unused lines on the COC form will be crossed out. Field personnel will sign all COC forms that are initiated in the field. The COC form will be placed in a waterproof plastic bag and taped to the inside of the shipping container used to transport the samples. Signed air bills will serve as evidence of custody transfer between field personnel and the courier and between the courier and the laboratory. Copies of the COC form and the air bill will be retained and filed by field personnel before the containers are shipped.

Laboratory COC forms are used when samples are received and continue to be used until samples are discarded. Laboratories analyzing samples under the Navy contract must follow custody procedures as stringent as are required by EPA's CLP SOWs (EPA 1999a, 2000a). The laboratory should designate a specific individual as the sample custodian. The custodian will receive all incoming samples, sign the accompanying custody forms, and retain copies of the forms as permanent records. The laboratory sample custodian will record all pertinent information concerning the samples, including the persons who delivered the samples, the date and time the sample is received, condition of the sample at the time it is received (sealed, unsealed, or broken container; temperature; or other relevant remarks), the sample ID numbers, and any unique laboratory ID numbers for the samples. This information should be entered into a computerized LIMS. When the sample transfer process is complete, the custodian is responsible for maintaining internal logbooks, tracking reports, and other records necessary to maintain custody throughout sample preparation and analysis.

The laboratory will provide a secure storage area for all samples. Access to this area will be restricted to authorized personnel. The custodian will ensure that samples requiring special handling, including samples that are heat- or light-sensitive, radioactive, or exhibit other unusual physical characteristics, will be properly stored and maintained before analysis.

2.3.5 Sample Shipment Procedures

The following procedures will be implemented when samples collected during this investigation are shipped to the fixed laboratory:

- The cooler will be filled with bubble wrap, sample bottles, and packing material. Sufficient packing material will be used to prevent sample containers from breaking during shipment. Enough ice will be added to maintain the sample temperature of below 4 °C, plus or minus 2 °C.
- The COC forms will be placed inside a plastic bag. The bag will be sealed and taped to the inside of the cooler lid. The air bill, if required, will be filled out before the samples are handed over to the carrier. The laboratory will be notified if the sampler suspects that the sample contains any substance that would require laboratory personnel to take safety precautions.
- The cooler will be closed and taped shut with strapping tape around both ends. If the cooler has a drain, it will be taped shut both inside and outside of the cooler.
- Signed and dated custody seals will be placed on all sample containers and the front and side of each cooler. If VOC vials are used, the vials will be placed in a plastic bag and the custody seal will be placed on the bag. Wide clear tape will be placed over the seals to prevent accidental breakage.
- The COC form will be transported within the taped, sealed cooler. When the cooler is received at the analytical laboratory, laboratory personnel will open the cooler and sign the COC form to document transfer of samples.

Multiple coolers may be sent in one shipment to the laboratory. In that case, the outside of the coolers will be marked to indicate the number of coolers in the shipment.

2.4 ANALYTICAL METHODS

Table 8 presents the analytical methods that will be used to analyze samples collected during this investigation. Appendix A presents the method precision and accuracy goals for the samples. Appendix C compares the PRRLs and the criteria used to evaluate the data.

Protocols for laboratory selection and for ensuring laboratory compliance with project analytical and QA/QC requirements are discussed below.

2.4.1 Selection of Fixed Laboratories

Fixed laboratories for this investigation will be selected from a list of prequalified laboratories developed by Tetra Tech to support Navy contracts. Prequalification streamlines laboratory selection by reducing the need to compile and review detailed bid and qualification packages for each individual investigation. Prequalification also improves flexibility in the program by allowing the analysis to be directed to various laboratories with available capacity at the time samples are collected.

The Tetra Tech team's laboratory prequalification and selection process relies on (1) a standard procedure to evaluate and prequalify laboratories for work under the contract, and (2) the Tetra Tech's SOW for Navy contracts (Tetra Tech 2002), a contractual document that specifies standard requirements for analyses that are routinely conducted. The Tetra Tech team establishes a basic ordering agreement that incorporates and enforces the laboratory SOW with each prequalified laboratory. Individual purchase orders can then be written for specific investigations. These aspects are further described in the sections below, along with Tetra Tech's procedures for selecting laboratories when the laboratory SOW does not specifically address project-specific analytical methods or QC requirements.

2.4.1.1 Laboratory Evaluation and Prequalification

Laboratories that support the Navy both directly or through subcontracts are evaluated and approved for Navy use by the Naval Facilities Engineering Service Center (NFESC). Laboratories that support the Navy contracts have been selected from the list of laboratories approved by NFESC and evaluated by Tetra Tech to assure that the laboratory can meet the technical requirements of the laboratory SOW and produce data of acceptable quality. The laboratories are evaluated in accordance with the NFESC *Installation Restoration Chemical Data Quality Manual* (NFESC 1999). The laboratory evaluation includes the following elements:

- **Certification and Approval.** Laboratories must be currently certified by the California Department of Health Services (DHS) Environmental Laboratory Accreditation Program (ELAP) for analysis of hazardous materials for each method specified. Laboratories must also have or obtain similar approval from NFESC. The DHS ELAP certification and NFESC approval must be obtained before the laboratory begins work.

- **Performance Evaluation (PE) Samples.** Each laboratory must initially and yearly demonstrate its ability to satisfactorily analyze single-blind PE samples for all analytical services it will provide under Navy contracts. At its discretion, Tetra Tech may submit one or more double-blind PE samples at Tetra Tech's cost. When the results for the PE sample are deficient, the laboratory must correct any problems and analyze (at its own cost) a subsequent round of PE samples for the deficient analysis.
- **Audits.** Laboratories must initially and yearly demonstrate their qualifications by submitting to one or more audits by Tetra Tech. The audits may consist of (1) an on-site review of laboratory facilities, personnel, documentation, and procedures, or (2) an off-site review of hard-copy and electronic deliverables or magnetic tapes. When deficiencies are identified, the laboratory must correct the problem and provide Tetra Tech with a written summary of the corrective action that was taken.

2.4.1.2 Laboratory Statement of Work

The laboratory SOW establishes standard requirements for the analytical methods that are most commonly used under Navy contracts. The laboratory SOW specifies standard method-specific target analyte lists and PRRLs, QC samples and associated control limits, calibration requirements, and miscellaneous method performance requirements for each method. The laboratory SOW also specifies standard data package requirements, EDD formats, data qualifiers, and delivery schedules. In addition, the laboratory SOW outlines support services (such as providing sample containers, trip blanks, temperature blanks, sample coolers, and COC forms and seals) that are expected of laboratories. The laboratory SOW incorporates Navy QA policy, as well as applicable EPA and state QA guidelines, as appropriate.

Tetra Tech's laboratory SOW is based on EPA CLP methods for VOCs, SVOCs, pesticides, and metals. The laboratory SOW also addresses frequently used non-CLP methods for a variety of organic, inorganic, and physical parameters. Non-CLP methods include the methods published by EPA in SW-846 (EPA 1996) and in "Methods for Chemical Analysis of Water and Waste" (EPA 1983); American Society for Testing and Materials (ASTM) methods; and others published by the American Public Health Association (APHA), American Water Works Association, and Water Pollution Control Federation in "Standard Methods for the Examination of Water and Waste Water" (APHA 1992). Laboratories on Tetra Tech's approved list can elect to provide all or a portion of the analytical services specified in the laboratory SOW.

As noted above, the laboratory SOW is incorporated into all laboratory subcontracts established for analytical services that support Navy projects. Therefore, the prequalified laboratories commit to meeting the requirements in the laboratory SOW during the contracting process before they receive samples. Tetra Tech regularly reviews and revises the laboratory SOW to incorporate new methods and requirements, modifications or updates to existing methods, changes in Navy QA policy or regulatory requirements, and any other necessary corrections or revisions.

2.4.1.3 Laboratory Selection and Oversight

After project-specific analytical and QA/QC requirements are identified and documented in the SAP, Tetra Tech's analytical coordinator works closely with Tetra Tech's procurement specialist to select a laboratory that can meet these requirements. When project-specific analytical and QC requirements are consistent with Tetra Tech's laboratory SOW, the analytical coordinator identifies one or more prequalified subcontractor laboratories that are capable of carrying out the work. As part of this process, the analytical coordinator typically contacts the laboratories to discuss the analytical requirements and project schedule. The analytical coordinator then forwards the name of the recommended laboratory (or laboratories) to the procurement specialist, who issues a purchase order for the work. When analytical requirements are consistent with Tetra Tech's laboratory SOW and multiple prequalified laboratories are capable of performing the work, a specific laboratory is selected based on workload and project schedule considerations.

Tetra Tech follows a similar procedure when project-specific analytical and QC requirements are nonstandard and differ from those specified in Tetra Tech's laboratory SOW. The analytical coordinator contacts analytical laboratories, beginning with any on Tetra Tech's prequalified list, to discuss the analytical and QA/QC requirements in the SAP and to assess the laboratories' ability to meet the requirements. In many cases, Tetra Tech works cooperatively with the analytical laboratories to develop and refine QC requirements for nonstandard analyses of matrices.

If the analytical coordinator is unable to identify one or more prequalified laboratories that can accept the work, additional laboratories are contacted. In general, the additional laboratories must be evaluated as described in Section 2.4.1.1 before they will be allowed to analyze any samples, although some steps in the evaluation may be waived for certain investigations and circumstances (for example, unusual analytes, urgent project needs, experimental methods, mobile laboratories, or on-site screening analyses). After additional laboratories have been identified, the analytical coordinator forwards their names to the procurement specialist. The procurement specialist prepares a solicitation package, including the project-specific analytical and QC requirements, and submits the package to the laboratories. The procurement specialist, in cooperation with the analytical coordinator and project manager, then evaluates the proposals that are received and selects a laboratory that meets the requirements and provides the best value to the Navy and Tetra Tech. Finally, the procurement specialist issues a purchase order to the laboratory selected that incorporates the project-specific analytical and QA/QC requirements.

After a laboratory has been selected, the analytical coordinator holds a kickoff meeting with the laboratory project manager. The kickoff meeting is held regardless of whether project-specific analytical and QA/QC requirements are consistent with the Tetra Tech's laboratory SOW or are outside the SOW. Tetra Tech's project manager, procurement specialist, and other key project and laboratory staff may be involved in this meeting. The kickoff meeting includes a review of analytical and QC requirements in the SAP, the project schedule, and any other logistical support that the laboratory will be expected to provide.

2.4.2 Project Analytical Requirements

One or more prequalified subcontractor laboratories will analyze groundwater samples off site for this investigation. The laboratories will be selected before the field program begins based on their ability to meet the project analytical and QC requirements, as well as the project schedule. Project analytical requirements are presented on Tables 8 and 9. The analytical methods for the project are standard methods that are described in Tetra Tech's laboratory SOW.

Samples will be analyzed for perchlorate using EPA Method 314.0. The reporting limits for EPA Method 314.0 exceed the screening level of 1 micrograms per liter (µg/L), therefore, all samples will be reanalyzed using liquid chromatography/mass spectrometry/mass spectrometry following modified EPA Method 8321 (dual MS). The potential modifications to EPA Method 8321 would be specific to the individual laboratory selected to analyze samples for perchlorate. The laboratory will provide the following documents for approval regarding modifications to Method 8321: method SOP, demonstration of capability at the action level, performance testing, method detection limit, and precision/accuracy studies.

This SAP documents project-specific QC requirements for the selected analytical methods. Sample volume, preservation, and holding time requirements are specified in Table 10. Requirements for laboratory QC samples are described in Table 5 and in Section 2.5. Appendix A includes project-specific precision and accuracy goals for the methods. Finally, Appendix C documents the PRRLs for each method.

2.5 QUALITY CONTROL

Tetra Tech will assess the quality of field data through regular collection and analysis of field QC samples. Laboratory QC samples will be analyzed in accordance with referenced analytical method protocols to ensure that laboratory procedures are conducted properly and that the quality of the data is known.

2.5.1 Field Quality Control Samples

QC samples are collected in the field and analyzed to check sampling and analytical precision, accuracy, and representativeness. This section discusses the types and purposes of field QC samples that will be collected for this investigation. Table 11 summarizes the types and frequency of collection for field QC samples and laboratory QC samples.

2.5.1.1 Field Duplicate Samples

Field duplicate samples will be collected at the same time and from the same source and then submitted as separate samples to the laboratory for analysis to evaluate the precision of field sampling. One field duplicate sample will be collected and analyzed for every 10 samples collected during the investigation. Duplicates are assigned normal sample ID numbers and are submitted blind to the laboratory.

TABLE 11: FIELD AND LABORATORY QC SAMPLES

Draft SAP, Additional Groundwater Investigation at Tidal Area Landfill, Site 1, Naval Weapons Station Seal Beach Detachment Concord, Concord, California

Sample Type	Frequency of Analysis
Field QC	
Field duplicate samples	One per 10 samples collected for analytes of concern
Equipment rinsate blank	One per day per type of sampling equipment
Source water blank	One per event per type of source water used
Trip blank	One per transport container containing volatiles
Temperature blank	One per transport container containing volatiles
Laboratory QC	
Method blank	One per 20 samples collected
MS/MSD	One per 20 samples collected
Laboratory control sample	One per 20 samples collected

Notes:

MS/MSD Matrix Spike/Matrix Spike Duplicate
QC Quality control
SAP Sampling and analysis plan

2.5.1.2 Equipment Rinsate Samples

Disposable sampling equipment will be used whenever possible during this investigation. If reusable equipment is used, equipment rinsate samples will be collected during groundwater sampling at a frequency of once per day of sampling per analyte of concern. An equipment rinsate is a sample collected after a sampling device is subjected to standard decontamination procedures. Water will be poured over or through the sampling equipment into a sample container and sent to the laboratory for analysis. Analytically certified, organic-free water or equivalent will be used for organic parameters; deionized or distilled water will be used for inorganic parameters.

During data validation, the results for the equipment rinsate samples will be used to qualify data or to evaluate the levels of analytes in the field samples collected on the same day.

2.5.1.3 Source Water Blank Samples

One source water blank will be collected for each sampling event and for each source of water (distilled, deionized, or from an industrial or residential water source).

2.5.1.4 Trip Blanks

A trip blank demonstrates that contamination is not originating from sample containers or from any factor during sample transport. A trip blank originates at the laboratory as a 40-milliliter vial typically used for analysis of VOCs and TPH-p. The vial is filled at the laboratory with reagent-grade, organic-free water. The trip blanks are then transported to the site with the empty containers that will be used for sample collection. The trip blanks are stored at the site until the proposed field samples have been collected. A trip blank will accompany each sample transport container that holds water samples for analysis of VOCs and TPH-p back to the laboratory. The trip blank is not opened until it is returned to the laboratory.

2.5.1.5 Temperature Blanks

A 40-milliliter vial will be included in each sample transport container including samples for analysis of VOCs and TPH-p. The vial will be filled with water, and will be used by the laboratory to determine the temperature of the samples upon arrival at the laboratory.

2.5.2 Laboratory Quality Control Samples

This section discusses the types of laboratory QC samples that will be used for this investigation. Table 11 summarizes the types and frequency of collection of laboratory QC samples. Appendix A presents project-specific precision and accuracy goals for these samples.

2.5.2.1 Matrix Spike and Matrix Spike Duplicates

MS/MSD samples for water matrices require collection of an additional volume of material for laboratory spiking and analysis. MS/MSD samples for groundwater will be collected at a frequency of 5 percent. The percent recoveries will be calculated for each spiked analyte and used to evaluate analytical accuracy. The RPD between spiked samples will be calculated to evaluate precision.

2.5.2.2 Method Blanks

Method blanks will be prepared at the frequency prescribed in the individual analytical method or at a rate of 5 percent of the total samples if a frequency is not prescribed in the method.

2.5.2.3 Laboratory Control Samples

LCSs, or blank spikes, will be analyzed at the frequency prescribed in the analytical method or at a rate of 5 percent of the total samples if a frequency is not prescribed in the method. If percent recovery results for the LCS or blank spike are outside of the established goals, laboratory-specific protocols will be followed to evaluate the usability of the data.

2.5.3 Additional Laboratory Quality Control Procedures

In addition to the analysis of laboratory QC samples, subcontractor laboratories will conduct the QC procedures discussed below.

2.5.3.1 Method Detection Limit Studies

The MDL is the minimum concentration of a compound that can be measured and reported. The MDL is a specified limit at which there is 99 percent confidence that the concentration of the analyte is greater than zero. The MDL accounts for sample matrix and preparation. The subcontractor laboratory will demonstrate the MDLs for all analyses except inorganic compounds and physical properties test methods.

MDL studies will be conducted annually for soil matrices, or more frequently if any method or instrumentation changes. Each MDL study will consist of seven replicates spiked with all target analytes of interest at concentrations no greater than the required quantitation limits. The replicates will be extracted and analyzed in the same manner as routine samples. If multiple instruments are used, each will be included in the MDL study. The MDLs reported will be representative of the least sensitive instrument.

2.5.3.2 Sample Quantitation Limits

Sample quantitation limits (SQL), also referred to as practical quantitation limits, are PRRLs adjusted for the characteristics of individual samples. The PRRLs presented in Appendix C are chemical-specific levels that a laboratory should be able to routinely detect and quantitate in a given sample matrix. The PRRL is usually defined in the analytical method or in laboratory method documentation. The SQL accounts for changes in preparation and analytical methodology that may alter the ability to detect an analyte, including changes such as use of a smaller sample aliquot or dilution of the sample extract. Physical characteristics such as sample matrix and percent moisture that may alter the ability to detect the analyte are also considered. The laboratory will calculate and report SQLs for all environmental samples.

2.5.3.3 Control Charts

Control charts document data quality in graphic form for specific method parameters such as surrogate standards and blank spike recoveries. A collection of data points for each parameter is used to statistically calculate means and control limits for an analytical method. This information is useful in evaluating whether analytical measurement systems are in control. In addition, control charts provide information about trends over time in specific analytical and preparation methodologies. Although they are not required, Tetra Tech recommends that subcontractor laboratories maintain control charts for organic and inorganic analyses. At a minimum, method blank surrogate recoveries and blank spike recoveries should be charted for all organic methods. Blank spike recoveries should be charted for methods used to analyze samples for inorganic compounds. Control charts should be updated monthly.

2.6 EQUIPMENT TESTING, INSPECTION, AND MAINTENANCE

This section outlines the testing, inspection, and maintenance procedures that will be used to keep both field and laboratory equipment in good working condition.

2.6.1 Maintenance of Field Equipment

Preventive maintenance for most field equipment is carried out in accordance with procedures and schedules recommended in the equipment manufacturer's literature or operating manual. However, more stringent testing, inspection, and maintenance procedures and schedules may be required when field equipment is used to make critical measurements.

A field instrument that is out of order will be segregated, clearly marked, and not used until it is repaired. The field team leader (FTL) will be notified of equipment malfunctions so that service can be completed quickly or substitute equipment can be obtained. When the condition of equipment is suspect, unscheduled testing, inspection, and maintenance should be conducted. Any significant problems with field equipment will be reported in the daily field QC report.

2.6.2 Maintenance of Laboratory Equipment

Subcontractor laboratories will prepare and follow a maintenance schedule for each instrument used to analyze samples collected for this investigation. All instruments will be serviced at scheduled intervals necessary to optimize factory specifications. Routine preventive maintenance and major repairs will be documented in a maintenance logbook.

An inventory of items to be kept ready for use in case of instrument failure will be maintained and restocked as needed. The list will include equipment parts subject to frequent failure, parts that have a limited lifetime of optimum performance, and parts that cannot be obtained in a timely manner.

The laboratory's QA plan and written SOPs will describe specific preventive maintenance procedures for equipment maintained by the laboratory. These documents identify the personnel responsible for major, preventive, and daily maintenance procedures; the frequency and type of maintenance performed; and procedures for documenting maintenance.

Laboratory equipment malfunctions will require immediate corrective action. Actions should be documented in laboratory logbooks. No other formal documentation is required unless data quality is adversely affected or further corrective action is necessary. On-the-spot corrective actions will be taken as necessary in accordance with the procedures described in the laboratory QA plan and SOPs.

2.7 INSTRUMENT CALIBRATION AND FREQUENCY

Proper instrument calibration is essential to ensure the accuracy of measurements made using field and laboratory equipment. Calibration procedures and frequency will be as described in the SOPs (Appendix B) or per the manufacturers' recommendations. Calibrations will be recorded on a calibration form (Appendix B) or in a field logbook.

2.8 INSPECTION AND ACCEPTANCE OF SUPPLIES AND CONSUMABLES

Tetra Tech project managers have primary responsibility for identifying the types and quantities of supplies and consumables needed to complete Navy projects and are responsible for establishing acceptance criteria for these items.

Supplies and consumables can be received either at the Tetra Tech office or at the site. When supplies are received, the project manager or FTL will sort them according to vendor, check packing slips against purchase orders, and inspect the condition of all supplies before they are accepted for use on a project. If an item does not meet the acceptance criteria, deficiencies will be noted on the packing slip and purchase order, and the item will then be returned to the vendor for replacement or repair.

Procedures for receiving supplies and consumables in the field are similar. Analytical laboratories are required to provide certified clean containers for all analyses. These containers must meet EPA standards described in "Specifications and Guidance for Obtaining Contaminant-Free Sampling Containers" (EPA 1992).

2.9 NONDIRECT MEASUREMENTS

No data for project implementation or decision-making will be obtained from nondirect measurement sources.

2.10 DATA MANAGEMENT

Field and analytical data collected from this project and other environmental investigations at NWSSBD Concord are critical to site characterization efforts, development of the comprehensive site conceptual model, risk assessments, and selection of remedial actions to protect human health and the environment. An information management system is necessary to ensure efficient access so that decisions based on the data can be made in a timely manner.

After the field and laboratory data reports are reviewed and validated, the data will be entered into Tetra Tech's database for NWSSBD Concord. The database contains data for (1) summarizing observations on contamination and geologic conditions, (2) preparing reports and graphics, (3) using with geographic information systems, and (4) transmitting in an electronic format compatible with NEDTS. The sections below describe Tetra Tech's data tracking procedures, data pathways, and overall data management strategy for NWSSBD Concord.

2.10.1 Data Tracking Procedures

All data that are generated in support of the Navy program at NWSSBD Concord are tracked through a database created by Tetra Tech. Information related to receipt and delivery of samples, project order fulfillment, and invoicing for laboratory and validation tasks is stored in Tetra Tech's program, SAMTRAK. All data are filed according to the document control number.

2.10.2 Data Pathways

Data are generated from three primary pathways at NWSSBD Concord: data derived from field activities, laboratory analytical data, and validated data. Data from all three pathways must be entered into the NWSSBD Concord database. Data pathways must be established and well documented to evaluate whether the data are accurately loaded into the database in a timely manner.

Data generated during field activities are recorded using field forms (Appendix B). The analytical coordinator or FTL reviews these forms for completeness and accuracy. Data from the field forms, including the COC form, are entered into SAMTRAK according to the document control number.

Data generated during laboratory analysis are recorded in hard copy and in EDDs after the samples have been analyzed. The laboratory will send the hard copy and EDD records to the analytical coordinator. The analytical coordinator reviews the data deliverable for completeness, accuracy, and format. After the format is approved, electronic data are manipulated and downloaded into the NWSSBD Concord database. Tetra Tech data entry personnel will then update SAMTRAK with the total number of samples received and number of days required to receive the data.

After they have been validated, the analytical coordinator reviews the data for accuracy. Tetra Tech personnel will then update the NWSSBD Concord database with the appropriate data qualifiers. SAMTRAK is also updated to record associated laboratory and data validation costs.

2.10.3 Data Management Strategy

Tetra Tech's short- and mid-term data management strategies require that the database for NWSSBD Concord be updated monthly. The data consist of chemical and field data from Navy contractors, entered into an Oracle (Version 7.3) database. The database can generate reports using available computer-aided drafting and design and contouring software. All electronic data from this database will be stored and maintained in a format compatible with NEDTS. Data will be handled in accordance with SWDIV Environmental Work Instruction #6, which specifies requirements for transmitting data to the Navy.

To satisfy long-term data management goals, the data will be loaded into Tetra Tech's database for storage, further manipulation, and retrieval after laboratory and field reports are reviewed and validated. The database will be used to provide data for chemical and geologic analysis and for preparing reports and graphic representations of the data. Additional data acquired from field activities are recorded on field forms (Appendix B) that are reviewed for completeness and accuracy by the analytical coordinator or FTL. Hard copies of forms, data, and COC forms are filed in a secure storage area according to project and document control numbers. Laboratory data packages and reports will be archived at Tetra Tech or Navy offices. Laboratories that generated the data will archive hard-copy data for a minimum of 10 years.

3.0 ASSESSMENT AND OVERSIGHT

This section describes the field and laboratory assessments that may be conducted during this project, the individuals responsible for conducting the assessments, the corrective actions that may be implemented in response to assessment results, and how quality-related issues will be reported to Tetra Tech and Navy management.

3.1 ASSESSMENT AND RESPONSE ACTIONS

Tetra Tech and the Navy will oversee collection of environmental data using the assessment and audit activities described below. Any problems encountered during an assessment of field investigation or laboratory activities will require appropriate corrective action to ensure that the problems are resolved. This section describes the types of assessments that may be completed, Tetra Tech and Navy responsibilities for conducting the assessments, and corrective action procedures to address problems identified during an assessment.

3.1.1 Field Assessments

Tetra Tech conducts field technical systems audits (TSA) on selected Navy projects to support data quality and encourage continuous improvement in the field systems that involve environmental data collection. The Tetra Tech QA program manager selects projects for field TSAs quarterly based on available resources and the relative significance of the field sampling effort. During the field TSA, the assessor will use personnel interviews, direct observations, and reviews of project-specific documentation to evaluate and document whether procedures specified in the approved SAP are being implemented. Specific items that may be observed during the TSA include:

- Availability of approved project plans such as the SAP and HASP
- Documentation of personnel qualifications and training
- Sample collection, identification, preservation, handling, and shipping procedures
- Sampling equipment decontamination
- Equipment calibration and maintenance
- Completeness of logbooks and other field records (including nonconformance documentation)

During the TSA, the Tetra Tech assessor will verbally communicate any significant deficiencies to the FTL for immediate correction. These and all other observations and comments will be documented in a TSA report. The TSA report will be issued to Tetra Tech’s project manager, FTL, program QA manager, and project QA officer in e-mail format within 7 days after the TSA is completed.

Tetra Tech’s program QA manager determines the timing and duration of TSAs. Generally, TSAs are conducted early in the project so that any quality issues can be resolved before large amounts of data are collected.

The Navy QA officer may independently conduct a field assessment of any Tetra Tech project. Items reviewed by the Navy QA officer during a field assessment may be similar to those described above.

3.1.2 Laboratory Assessments

As described in Section 2.4.1, NFESC assesses all laboratories before they are allowed to analyze samples under Navy contracts. Tetra Tech also conducts a preaward assessment of each laboratory before it is entered on the approved list for work under the Navy contracts (Appendix D). These assessments include (1) reviews of laboratory certifications, (2) initial and annual demonstrations of the laboratory's ability to satisfactorily analyze single-blind PE samples, and (3) laboratory audits. Laboratory audits may consist of an on-site review of laboratory facilities, personnel, documentation, and procedures, or an off-site evaluation of the ability of the laboratory's data management system to meet contract requirements. Tetra Tech also conducts an assessment when an approved laboratory has been selected for nonroutine analyses or when a laboratory that is not on the approved list must be used.

Tetra Tech will conduct a TSA of the laboratory selected for this project after the laboratory receives and begins processing samples. The purpose of this TSA will be to review project-specific implementation of the methods specified in this SAP and to ensure that appropriate QC procedures are being implemented in association with these methods.

The Navy also may audit any laboratory that will analyze samples on this project. The Navy QA officer will determine the need for and typically will conduct the audits before samples are submitted to the laboratory for analysis.

3.1.3 Assessment Responsibilities

Tetra Tech personnel who conduct assessments will be independent of the activity evaluated. Tetra Tech's program QA manager will select the appropriate personnel to conduct each assessment and will assign them responsibilities and deadlines for completing the assessment. These personnel may include the program QA manager, project QA officer, or senior technical staff with relevant expertise and experience in assessment.

When an assessment is planned, Tetra Tech's program QA manager selects a lead assessor who is responsible for:

- Selecting and preparing the assessment team
- Preparing an assessment plan
- Coordinating and scheduling the assessment with the project team, subcontractor, or other organization being evaluated
- Participating in the assessment
- Coordinating preparation and issuance of assessment reports and corrective action request forms
- Evaluating responses and resulting corrective actions

After a TSA is completed, the lead assessor will submit an audit report to Tetra Tech's QA manger, project manager, and project QA officer; other personnel may be included in the distribution as appropriate. Assessment findings will also be included in the QC summary report (QCSR) for the project (Section 3.2.3).

The Navy QA officer is responsible for coordinating all audits that may be conducted by Navy personnel under this project. Audit preparation, completion, and reporting responsibilities for Navy auditors would be similar to those described above.

3.1.4 Field Corrective Action Procedures

Field corrective action procedures will depend on the type and severity of the finding. Tetra Tech classifies assessment findings as either deficiencies or observations. Deficiencies are findings that may significantly affect data quality and that will require corrective action. Observations are findings that do not directly affect data quality, but are suggestions for consideration and review.

Project teams are required to respond to deficiencies identified in TSA reports. The project manager, FTL, and project QA officer will discuss the deficiencies and the appropriate steps to resolve each deficiency by:

- Determining when and how the problem developed
- Assigning responsibility for problem investigation and documentation
- Selecting the corrective action to eliminate the problem
- Developing a schedule for completing the corrective action
- Assigning responsibility for implementing the corrective action
- Documenting and verifying that the corrective action has eliminated the problem
- Notifying the Navy of the problem and the corrective action taken

In responding to the TSA report, the project team will briefly describe each deficiency, the proposed corrective action, the individual responsible for selecting and implementing the corrective action, and the completion dates for each corrective action. The project QA officer will use a status report to monitor all corrective actions.

Tetra Tech's program QA manager is responsible for reviewing proposed corrective actions and verifying that they have been effectively implemented. The program QA manager can require data acquisition to be limited or discontinued until the corrective action is complete and a deficiency is eliminated. The program QA manager can also request reanalysis of any or all samples and review of all data acquired since the system was last in control.

3.1.5 Laboratory Corrective Action Procedures

Internal laboratory procedures for corrective action and descriptions of out-of-control situations that require corrective action are contained in laboratory QA plans. At a minimum, corrective action will be implemented when any of the following three conditions occurs: (1) control limits are exceeded, (2) method QC requirements are not met, or (3) sample holding times are exceeded. The laboratory will report out-of-control situations to the Tetra Tech analytical coordinator within 2 working days after they are identified. In addition, the laboratory project manager will prepare and submit a corrective action report to the Tetra Tech analytical coordinator. This report will identify the out-of-control situation and the steps that the laboratory has taken to rectify it.

3.2 REPORTS TO MANAGEMENT

Effective management of environmental data collection requires (1) timely assessment and review of all activities, and (2) open communication, interaction, and feedback among all project participants. Tetra Tech will use the reports described below to address any project-specific quality issues and to facilitate timely communication of these issues.

3.2.1 Daily Progress Reports

Tetra Tech will prepare a daily progress report to summarize activities throughout the field investigation. This report will describe sampling and field measurements, equipment used, Tetra Tech and subcontractor personnel on site, QA/QC and health and safety activities, problems encountered, corrective actions taken, deviations from the SAP, and explanations for the deviations. The daily progress report is prepared by the FTL and submitted to the project manager and to the Navy remedial project manager (RPM), if requested. The content of the daily reports will be summarized and included in the final report submitted for the field investigation.

3.2.2 Project Monthly Status Report

The Tetra Tech project manager will prepare a monthly status report (MSR) to be submitted to Tetra Tech's program manager and the Navy RPM. MSRs address project-specific quality issues and facilitate their timely communication. The MSR will include the following quality-related information:

- Project status
- Instrument, equipment, or procedural problems that affect quality and recommended solutions
- Objectives from the previous report that were achieved
- Objectives from the previous report that were not achieved
- Work planned for the next month

If appropriate, Tetra Tech will obtain similar information from subcontractors who are participating in the project and will incorporate the information within the MSR.

3.2.3 Quality Control Summary Report

Tetra Tech will prepare a QCSR that will be submitted to the Navy RPM with the final report for the field investigation. The QCSR will include a summary and evaluation of QA/QC activities, including any field or laboratory assessments, completed during the investigation. The QCSR will also indicate the location and duration of storage for the complete data packages. The QCSR will emphasize whether project DQOs were met and whether data are of adequate quality to support required decisions.

4.0 DATA VALIDATION AND USABILITY

This section describes the procedures that are planned to review, verify, and validate field and laboratory data. This section also discusses procedures for verifying that the data are sufficient to meet DQOs and MQOs for the project.

4.1 DATA REVIEW, VERIFICATION, AND VALIDATION

Validation and verification of the data generated during field and laboratory activities are essential to obtaining defensible data of acceptable quality. Verification and validation methods for field and laboratory activities are presented below.

4.1.1 Field Data Verification

Project team personnel will verify field data through reviews of data sets to identify inconsistencies or anomalous values. Any inconsistencies discovered will be resolved as soon as possible by seeking clarification from field personnel responsible for data collection. All field personnel will be responsible for following the sampling and documentation procedures described in this SAP so that defensible and justifiable data are obtained.

Data values that are significantly different from the population are called “outliers.” A systematic effort will be made to identify any outliers or errors before field personnel report the data. Outliers can result from improper sampling or measurement methodology, data transcription errors, calculation errors, or natural causes. Outliers that result from errors found during data verification will be identified and corrected; outliers that cannot be attributed to errors in sampling, measurement, transcription, or calculation will be clearly identified in project reports.

4.1.2 Laboratory Data Verification

Laboratory personnel will verify analytical data at the time of analysis and reporting and through subsequent reviews of the raw data for any nonconformances to the requirements of the analytical method. Laboratory personnel will make a systematic effort to identify any outliers or errors before they report the data. Outliers that result from errors found during data verification will be identified and corrected; outliers that cannot be attributed to errors in analysis, transcription, or calculation will be clearly identified in the case narrative section of the analytical data package.

4.1.3 Laboratory Data Validation

An independent third-party contractor will validate all laboratory data (except IDW characterization) in accordance with current EPA national functional guidelines (EPA 1994, 1999b). The data validation strategy will be consistent with Navy guidelines. For this project, 90 percent of the data for analytes of concern will undergo cursory validation and 10 percent of the data for analytes of concern will undergo full validation. Requirements for cursory and full validation are listed below.

4.1.3.1 Cursory Data Validation

Cursory validation will be completed on 80 percent of the summary data packages for analysis of analytes of concern. The data reviewer is required to notify Tetra Tech and request any missing information needed from the laboratory. Elimination of the data from the review process is not allowed. All data will be qualified as necessary in accordance with established criteria. Data summary packages will consist of sample results and QC summaries, including calibration and internal standard data.

4.1.3.2 Full Data Validation

Full validation will be completed on 20 percent of the full data packages for analysis of analytes of concern. The data reviewer is required to notify Tetra Tech and request any missing information needed from the laboratory. Elimination of data from the review process is not allowed. All data will continue through the validation process and will be qualified in accordance with established criteria. Data summary packages will consist of sample results, QC summaries, and all raw data associated with the sample results and QC summaries.

4.1.3.3 Data Validation Criteria

Table 12 lists the QC criteria that will be reviewed for both cursory and full data validation. The data validation criteria selected from Table 12 will be consistent with the project-specific analytical methods referenced in Section 2.4 of the SAP.

4.2 RECONCILIATION WITH USER REQUIREMENTS

After environmental data are reviewed, verified, and validated in accordance with the procedures described in Section 4.1, the data must be further evaluated to determine whether DQOs have been met.

TABLE 12: DATA VALIDATION CRITERIA
Draft SAP, Additional Groundwater Investigation at Tidal Area Landfill, Site 1,
Naval Weapons Station Seal Beach Detachment Concord, Concord, California

Analytical Parameter Group	Cursory Data Validation Criteria	Full Data Validation Criteria
Non-CLP Organic Analyses	Method compliance Holding times Calibration Blanks Surrogate recovery MS/MSD recovery LCS or blank spike Internal standard performance Field duplicate sample analysis Other laboratory QC specified by the method Overall assessment of data for an SDG	Method compliance Holding times Calibration Blanks Surrogate recovery MS/MSD recovery LCS or blank spike Internal standard performance Compound identification Detection limits Compound quantitation Sample results verification Other laboratory QC specified by the method Overall assessment of data for an SDG
Non-CLP Inorganic Analyses	Method compliance Holding times Calibration Blanks MS/MSD recovery LCS or blank spike Field duplicate sample analysis Other laboratory QC specified by the method Overall assessment of data for an SDG	Method compliance Holding times Calibration Blanks MS/MSD recovery LCS Field duplicate sample analysis Other laboratory QC specified by the method Detection limits Analyte identification Analyte quantitation Sample results verification Overall assessment of data for an SDG

Notes:

CLP	Contract Laboratory Program
LCS	Laboratory control sample
MS/MSD	Matrix spike/matrix spike duplicate
QC	Quality control
SAP	Sampling and analysis plan
SDG	Sample delivery group

To the extent possible, Tetra Tech will follow EPA's data quality assessment (DQA) process to verify that the type, quality, and quantity of data collected are appropriate for their intended use. DQA methods and procedures are outlined in EPA's "Guidance for Data Quality Assessment, Practical Methods for Data Analysis, EPA QA/G-9, QA00 Update" (EPA 2000d). The DQA process includes the following five steps: (1) review the DQOs and sampling design, (2) conduct a preliminary data review, (3) select a statistical test, (4) verify the assumptions of the statistical test, and (5) draw conclusions from the data.

When the five-step DQA process is not completely followed because the DQOs are qualitative, Tetra Tech will systematically assess data quality and data usability. This assessment will include:

- A review of the sampling design and sampling methods to verify that they were implemented as planned and are adequate to support project objectives.
- A review of project-specific data quality indicators for PARRC parameters and quantitation limits (defined in Section 1.3.2) to determine whether acceptance criteria have been met.
- A review of project-specific DQOs to determine whether they have been achieved by the data collected.
- An evaluation of any limitations associated with the decisions to be made based on the data collected. For example, if data completeness is only 90 percent compared with a project-specific completeness objective of 95 percent, the data may still be usable to support a decision, but at a lower level of confidence.

The final report for the project will discuss any potential affects of these reviews on data usability and will clearly define any limitations associated with the data.

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Bouwer, H. and Rice, R.C. 1976. "A Slug Test for Determining Hydraulic Conductivity of Unconfined Aquifers with Completely or Partially Penetrating Wells." Water Resources Research. Volume 12, Number 3. June.

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APPENDIX A
METHOD PRECISION AND ACCURACY GOALS

TABLE A-1: PRECISION AND ACCURACY GOALS

Draft SAP, Additional Groundwater Investigation at Tidal Area Landfill, Site 1,
Naval Weapons Station Seal Beach Detachment Concord, Concord, California

Compound	QC Type	Analytical Method	Precision (RPD)(a)	Accuracy (% Rec)(b)
			Water	Water
Total petroleum hydrocarbons-extractable				
Diesel	MS/MSD	EPA 8015B/CA LUFT Manual	50	50-150
Diesel	LCS	EPA 8015B/CA LUFT Manual	NA	60–140
Hexacosane	Surrogate	EPA 8015B/CA LUFT Manual	NA	60-140
Total petroleum hydrocarbons-purgeable				
Gasoline	MS/MSD	EPA 8015B/CA LUFT Manual	30	70-130
Gasoline	LCS	EPA 8015B/CA LUFT Manual	NA	75–125
Bromofluorobenzene	Surrogate	EPA 8015B/CA LUFT Manual	NA	75-125
Metals				
All metals[RTO21]	Matrix Spike	EPA 6010B/7000A/1631	NA	75-125
Metals	LCS	EPA 6010B/7000A	NA	80-120
Mercury	LCS	EPA 1631	NA	75-125
All metals	Duplicate	EPA 6010B/7000A	20	NA
Hexavalent Chromium				
Hexavalent chromium[RTO22]	MS, LCS	EPA 7196A	NA	85-115
Hexavalent chromium	Duplicate	EPA 7196A	20	NA
Volatile Organic Compounds				
1,1-Dichloroethene	MS/MSD, LCS	EPA 8260B	14	61-145
Trichloroethene	MS/MSD, LCS	EPA 8260B	14	71-120
Benzene	MS/MSD, LCS	EPA 8260B	11	76-127
Toluene	MS/MSD, LCS	EPA 8260B	13	76-125
Chlorobenenze	MS/MSD, LCS	EPA 8260B	13	75-130
Toluene-d8	Surrogate	EPA 8260B	NA	88-110
Bromofluorobenzene	Surrogate	EPA 8260B	NA	86-115
1,2-Dichloroethane-d4	Surrogate	EPA 8260B	NA	76-114

TABLE A-1: PRECISION AND ACCURACY GOALS (Continued)
Internal Draft SAP, Additional Groundwater Investigation at Tidal Area Landfill, Site 1,
Naval Weapons Station Seal Beach Detachment Concord, Concord, California

Compound	QC Type	Analytical Method	Precision (RPD)(a)	Accuracy (% Rec)(b)
			Water	Water
Semivolatile Organic Compounds				
Acenaphthene	MS/MSD, LCS	EPA 8270C	31	46-118
2,4-Dinitrotoluene	MS/MSD, LCS	EPA 8270C	38	24-96
Pyrene	MS/MSD, LCS	EPA 8270C	31	26-127
N-Nitroso-di-n-propylamine	MS/MSD, LCS	EPA 8270C	38	41-116
Pentachlorophenol	MS/MSD, LCS	EPA 8270C	50	9-103
Phenol	MS/MSD, LCS	EPA 8270C	42	12-110
2-Chlorophenol	MS/MSD, LCS	EPA 8270C	40	27-123
4-Chloro-3-methylphenol	MS/MSD, LCS	EPA 8270C	42	23-97
4-Nitrophenol	MS/MSD, LCS	EPA 8270C	50	10-80
Nitrobenzene-d5	Surrogate	EPA 8270C	NA	35-114
2-Fluorobiphenyl	Surrogate	EPA 8270C	NA	43-116
p-Terphenyl-d14	Surrogate	EPA 8270C	NA	33-141
Phenol-d5	Surrogate	EPA 8270C	NA	10-110
2-Fluorophenol	Surrogate	EPA 8270C	NA	21-110
2,4,6-Tribromophenol	Surrogate	EPA 8270C	NA	10-123
Pesticides				
gamma-BHC	MS/MSD, LCS	EPA 8081A	15	56-123
Heptachlor	MS/MSD, LCS	EPA 8081A	20	40-131
Aldrin	MS/MSD, LCS	EPA 8081A	22	40-120
Dieldrin	MS/MSD, LCS	EPA 8081A	18	52-126
Endrin	MS/MSD, LCS	EPA 8081A	21	56-121
4,4-DDT	MS/MSD, LCS	EPA 8081A	27	38-127
Tetra-m-xylene	Surrogate	EPA 8081A	NA	30-150
Decachlorobiphenyl	Surrogate	EPA 8081A	NA	30-150

TABLE A-1: PRECISION AND ACCURACY GOALS (Continued)
Internal Draft SAP, Additional Groundwater Investigation at Tidal Area Landfill, Site 1,
Naval Weapons Station Seal Beach Detachment Concord, Concord, California

Compound	QC Type	Analytical Method	Precision (RPD)(a)	Accuracy (% Rec)(b)
			Water	Water
Explosives				
HMX	MS/MSD, LCS	EPA 8330	50	50-150
RDX	MS/MSD, LCS	EPA 8330	50	50-150
1,3,5-Trinitrobenzene	MS/MSD, LCS	EPA 8330	50	50-150
1,3-Dinitrobenzene	MS/MSD, LCS	EPA 8330	50	50-150
Tetryl	MS/MSD, LCS	EPA 8330	50	50-150
Nitrobenzene	MS/MSD, LCS	EPA 8330	50	50-150
4-Amino-2,6-dinitrotoluene	MS/MSD, LCS	EPA 8330	50	50-150
2-Amino-4,6-dinitrotoluene	MS/MSD, LCS	EPA 8330	50	50-150
2,4,6-Trinitrotoluene	MS/MSD, LCS	EPA 8330	50	50-150
2,6-Dinitrotoluene	MS/MSD, LCS	EPA 8330	50	50-150
2,4-Dinitrotoluene	MS/MSD, LCS	EPA 8330	50	50-150
2-Nitrotoluene	MS/MSD, LCS	EPA 8330	50	50-150
4-Nitrotoluene	MS/MSD, LCS	EPA 8330	50	50-150
3-Nitrotoluene	MS/MSD, LCS	EPA 8330	50	50-150
1-Chloro-3-nitrobenzene	Surrogate	EPA 8330	NA	65-107
Perchlorate				
Perchlorate	MS/MSD	EPA 314.0	20	80-120
Perchlorate	LCS	EPA 314.0	NA	85-115
Perchlorate	MS/MSD	Modified EPA 83231A, LC/MS/MS	40	50-150
Perchlorate	LCS	Modified EPA 83231A, LC/MS/MS	30	70-130
Miscellaneous Analytes				
Total dissolved solids	Duplicate	EPA 160.1	20	NA
Total suspended solids	Duplicate	EPA 160.2	20	NA
General anions	MS	EPA 300.1	20	80-120

TABLE A-1: PRECISION AND ACCURACY GOALS (Continued)

Internal Draft SAP, Additional Groundwater Investigation at Tidal Area Landfill, Site 1,
Naval Weapons Station Seal Beach Detachment Concord, Concord, California

Notes:

a	Precision as relative percent difference (RPD)
b	Accuracy as percent recovery (% Rec)
CA LUFT	State of California. 1989. "LUFT Field Manual: Guidelines for Site Assessment, Cleanup, and Underground Storage Tank Closure." Leaking Underground Fuel Tank Task Force. October.
EPA	U.S. Environmental Protection Agency
LCS	Laboratory control spike (blank spike)
MS/MSD	Matrix spike and matrix spike duplicate
NA	Not applicable
%Rec	Percent recovery
QC	Quality control
RPD	Relative percent difference

APPENDIX B
STANDARD OPERATING PROCEDURES AND FIELD FORMS

Standard Operating Procedures

002 General Equipment Decontamination

020 Monitoring Well Installation

021 Monitoring Well Development

Field Forms

Groundwater Sampling Form

Instrument Calibration Form

Monitoring Well Development Form

Daily Tailgate Safety Meeting Form

SOP APPROVAL FORM

TETRA TECH EM INC.

ENVIRONMENTAL STANDARD OPERATING PROCEDURE

GENERAL EQUIPMENT DECONTAMINATION

SOP NO. 002

REVISION NO. 2

Last Reviewed: December 1999

RRiesing

Quality Assurance Approved

February 2, 1993

Date

1.0 BACKGROUND

All nondisposable field equipment must be decontaminated before and after each use at each sampling location to obtain representative samples and to reduce the possibility of cross-contamination.

1.1 PURPOSE

This standard operating procedure (SOP) establishes the requirements and procedures for decontaminating equipment in the field.

1.2 SCOPE

This SOP applies to decontaminating general nondisposable field equipment. To prevent contamination of samples, all sampling equipment must be thoroughly cleaned prior to each use.

1.3 DEFINITIONS

Alconox: Nonphosphate soap

1.4 REFERENCES

U.S. Environmental Protection Agency (EPA). 1992. "RCRA Ground-Water Monitoring: Draft Technical Guidance. Office of Solid Waste. Washington, DC. EPA/530-R-93-001. November.

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1.5 REQUIREMENTS AND RESOURCES

The equipment required to conduct decontamination is as follows:

- Scrub brushes
- Large wash tubs or buckets
- Squirt bottles

- Alconox
- Tap water
- Distilled water
- Plastic sheeting
- Aluminum foil
- Methanol or hexane
- Dilute (0.1 N) nitric acid

2.0 PROCEDURE

The procedures below discuss decontamination of personal protective equipment (PPE), drilling and monitoring well installation equipment, borehole soil sampling equipment, water level measurement equipment, and general sampling equipment.

2.1 PERSONAL PROTECTIVE EQUIPMENT DECONTAMINATION

Personnel working in the field are required to follow specific procedures for decontamination prior to leaving the work area so that contamination is not spread off-site or to clean areas. All used disposable protective clothing, such as Tyvek coveralls, gloves, and booties, will be containerized for later disposal. Decontamination water will be containerized in 55-gallon drums.

Personnel decontamination procedures will be as follows:

1. Wash neoprene boots (or neoprene boots with disposable booties) with Liquinox or Alconox solution and rinse with clean water. Remove booties and retain boots for subsequent reuse.

2. Wash outer gloves in Liquinox or Alconox solution and rinse in clean water. Remove outer gloves and place into plastic bag for disposal.

3. Remove Tyvek or coveralls. Containerize Tyvek for disposal and place coveralls in plastic bag for reuse.

4. Remove air purifying respirator (APR), if used, and place the spent filters into a plastic bag for disposal. Filters should be changed daily or sooner depending on use and application. Place respirator into a separate plastic bag after cleaning and disinfecting.

5. Remove disposable gloves and place them in plastic bag for disposal.

6. Thoroughly wash hands and face in clean water and soap.

2.2 DRILLING AND MONITORING WELL INSTALLATION EQUIPMENT DECONTAMINATION

All drilling equipment should be decontaminated at a designated location on-site before drilling operations begin, between borings, and at completion of the project.

Monitoring well casing, screens, and fittings are assumed to be delivered to the site in a clean condition. However, they should be steam cleaned on-site prior to placement downhole. The drilling subcontractor will typically furnish the steam cleaner and water.

After cleaning the drilling equipment, field personnel should place the drilling equipment, well casing and screens, and any other equipment that will go into the hole on clean polyethylene sheeting.

The drilling auger, bits, drill pipe, temporary casing, surface casing, and other equipment should be decontaminated by the drilling subcontractor by hosing down with a steam cleaner until thoroughly clean. Drill bits and tools that still exhibit particles of soil after the first washing should be scrubbed with a wire brush and then rinsed again with a high-pressure steam rinse.

All wastewater from decontamination procedures should be containerized.

2.3 BOREHOLE SOIL SAMPLING EQUIPMENT DECONTAMINATION

The soil sampling equipment should be decontaminated after each sample as follows:

1. Prior to sampling, scrub the split-barrel sampler and sampling tools in a bucket using a stiff, long bristle brush and Liquinox or Alconox solution.

2. Steam clean the sampling equipment over the rinsate tub and allow to air dry.

3. Place cleaned equipment in a clean area on plastic sheeting and wrap with aluminum foil.

4. Containerize all water and rinsate.

5. Decontaminate all pipe placed down the hole as described for drilling equipment.

2.4 WATER LEVEL MEASUREMENT EQUIPMENT DECONTAMINATION

Field personnel should decontaminate the well sounder and interface probe before inserting and after removing them from each well. The following decontamination procedures should be used:

1. Wipe the sounding cable with a disposable soap-impregnated cloth or paper towel.
2. Rinse with deionized organic-free water.

2.5 GENERAL SAMPLING EQUIPMENT DECONTAMINATION

All nondisposable sampling equipment should be decontaminated using the following procedures:

1. Select an area removed from sampling locations that is both downwind and downgradient. Decontamination must not cause cross-contamination between sampling points.
2. Maintain the same level of protection as was used for sampling.
3. To decontaminate a piece of equipment, use an Alconox wash; a tap water wash; a solvent (methanol or hexane) rinse, if applicable or dilute (0.1 N) nitric acid rinse, if applicable; a distilled water rinse; and air drying. Use a solvent (methanol or hexane) rinse for grossly contaminated equipment (for example, equipment that is not readily cleaned by the Alconox wash). The dilute nitric acid rinse may be used if metals are the analyte of concern.
4. Place cleaned equipment in a clean area on plastic sheeting and wrap with aluminum foil.
5. Containerize all water and rinsate.

SOP APPROVAL FORM

TETRA TECH EM INC.

ENVIRONMENTAL STANDARD OPERATING PROCEDURE

MONITORING WELL INSTALLATION

SOP NO. 020

REVISION NO. 3

Last Reviewed: December 2000

R Riesing	*December 19, 2000*
Quality Assurance Approved	Date

1.0 BACKGROUND

Groundwater monitoring wells are designed and installed for a variety of reasons including: (1) detecting the presence or absence of contaminants, (2) collecting groundwater samples representative of in situ aquifer chemical characteristics, or (3) measuring water levels for determining groundwater potentiometric head and groundwater flow direction.

Although detailed specifications for well installation may vary in response to site-specific conditions, some elements of well installation are common to most situations. This standard operating procedure (SOP) discusses common methods and minimum standards for monitoring well installation for Tetra Tech EM Inc. (Tetra Tech) projects. The SOP is based on widely recognized methods described by the U.S. Environmental Protection Agency (EPA) and American Society for Testing and Materials (ASTM). However, well type, well construction, and well installation methods will vary with drilling method, intended well use, subsurface characteristics, and other site-specific criteria. In addition, monitoring wells should be constructed and installed in a manner consistent with all local and state regulations. Detailed specifications for well installation should be identified within a site-specific work plan, sampling plan, or quality assurance project plan (QAPP).

General specifications and installation procedures for the following monitoring well components are included in this SOP:

- Monitoring well materials
  - Casing materials
  - Well screen materials
  - Filter pack materials
  - Annular sealant (bentonite pellets or chips)
  - Grouting materials
  - Tremie pipe
  - Surface completion and protective casing materials
  - Concrete surface pad and bumper posts
  - Uncontaminated water
- Monitoring well installation procedures
  - Well screen and riser placement
  - Filter pack placement
  - Temporary casing retrieval

- Annular seal placement
- Grouting
- Surface completion and protective casing (aboveground and flush-mount)
- Concrete surface pad and bumper posts
- Permanent and multiple casing well installation

• Recordkeeping procedures

- Surveying
- Permits and well construction records
- Monitoring well identification

Well installation methods will depend to some extent on the boring method. Specific boring or drilling protocols are detailed in other SOPs. The boring method, in turn, will depend on site-specific geology and hydrogeology and project requirements. Boring methods commonly used for well installation include:

• Hollow-stem augering
• Cable tool drilling
• Mud rotary drilling
• Air rotary drilling
• Rock coring

The hollow-stem auger method is preferred in areas where subsurface materials are unconsolidated or loosely consolidated and where the depth of the boring will be less than 100 feet. This maximum effective depth for hollow-stem augering depends on the diameter of the augers, the formation characteristics, and the strength and durability of the drilling equipment. This method is preferred because under the right conditions it is cost effective, addition of water into the subsurface is limited, continuous soil samples can easily be collected, and monitoring wells can easily be constructed within the hollow augers.

Cable tool drilling is a preferred method when the subsurface contains boulders, coarse gravels, or flowing sands, or when the operational depth of the hollow-stem auger is exceeded. However, this method is slow.

Rotary methods are generally used when other methods cannot be used. The use of drilling fluids or large amounts of water to maintain an open borehole, and the difficulty in obtaining representative samples limit the utility of rotary methods. However, rotary methods can be used to quickly and effectively drill deep wells through consolidated or unconsolidated materials. Modifications to this method such as dual-tube drilling procedures, drill-through casing hammers, or eccentric-type drill systems, can reduce the amount of fluids introduced into the well borehole.

Rock coring is an effective method when drilling in competent consolidated rock. Intact, continuous cores can be obtained, and limited amounts of fluid are required if the formations are not fractured.

1.1 PURPOSE

This SOP establishes the requirements and procedures for monitoring well installation. Monitoring wells should be designed to function properly throughout the duration of the monitoring program. The performance objectives for monitoring well installation are as follows:

- Ensure that the monitoring well will provide water samples representative of in situ aquifer conditions.
- Ensure that the monitoring well construction will last for duration of the project.
- Ensure that the monitoring well will not serve as a conduit for vertical migration of contaminants, particularly vertical migration between discrete aquifers.
- Ensure that the well diameter is adequate for all anticipated downhole monitoring and sampling equipment.

1.2 SCOPE

This SOP applies to the installation of monitoring wells. Although some of the procedures may apply to the installation of water supply wells, this SOP is not intended to cover the design and construction of such wells. The SOP identifies several well drilling methods related to monitoring well installation, but the scope of this SOP does not include drilling methods.

Other relevant SOPs include SOP 002 for decontamination of drilling and well installation equipment, SOP 005 for soil sampling, SOP 021 for monitoring well development, SOPs 010 and 015 for groundwater sampling from monitoring wells, and SOP 014 for measuring static water levels within monitoring wells.

1.3 DEFINITIONS

Annulus: The space between the monitoring well casing and the wall of the well boring.

Bentonite seal: A colloidal clay seal separating the sand pack from the annular grout seal.

Centralizer: A stainless-steel or plastic spacer that keeps the well screen and casing centered in the borehole.

Filter pack: A clean, uniform sand or gravel placed between the borehole wall and the well screen to prevent formation material from entering the screen.

Grout seal: A fluid mixture of (1) bentonite and water, (2) cement, bentonite, and water, or (3) cement and water placed above the bentonite seal between the casing and the borehole wall to secure the casing in place and keep water from entering the borehole.

Tremie pipe: A rigid pipe used to place the well filter pack, bentonite seal, or grout seal. The tremie pipe is lowered to the bottom of the well or area to be filled and pulled up ahead of the material being placed.

Well casing: A solid piece of pipe, typically polyvinyl chloride (PVC) or stainless steel, used to keep a well open in either unconsolidated material or unstable rock.

Well screen: A PVC or stainless steel pipe with openings of a uniform width, orientation, and spacing used to keep materials other than water from entering the well and to stabilize the surrounding formation.

1.4 REFERENCES

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1.5 REQUIREMENTS AND RESOURCES

Well installation requires a completed boring with stable or supported walls. The type of drilling rig needed to complete the boring and the well construction materials required for monitoring well installation will depend on the drilling method used, the geologic formations present, and chemicals of concern in groundwater. The rig and support equipment used to drill the borehole is usually used to install the well. Under most conditions, the following items are also required for the proper installation of monitoring wells:

- Tremie pipe and funnel
- Bentonite pellets or chips
- Grouting supplies
- Casing materials
- Well screen materials
- Filter pack materials
- Surface completion materials (protective casing, lockable and watertight well cover, padlock)
- Electronic water level sounding device for water level measurement
- Measuring tape with weight for measuring the depth of the well and determining the placement of filter pack materials
- Decontamination equipment and supplies

- Site-specific work plan, field sampling plan, health and safety plan, and QAPP
- Monitoring Well Completion Record (see Figure 1)

2.0 MONITORING WELL INSTALLATION PROCEDURES

This section presents standard procedures for monitoring well installation and is divided into three subsections. Section 2.1 addresses monitoring well construction materials, while Section 2.2 describes typical monitoring well installation procedures. Section 2.3 addresses recordkeeping requirements associated with monitoring well installation. Monitoring well installation procedures described in work plans, sampling plans, and QAPPs should be fully consistent with the procedures outlined in this SOP as well as any applicable local and state regulations and guidelines.

2.1 MONITORING WELL CONSTRUCTION MATERIALS

Monitoring well construction materials should be specified in the site-specific work plan as well as in the statement of work for any subcontractors assisting in the well installation. Well construction materials that come in contact with groundwater should not measurably alter the chemical quality of groundwater samples with regard to the constituents being examined. The riser, well screen, and filter pack and annular sealant placement equipment should be steam cleaned or high-pressure water cleaned immediately prior to well installation. Alternatively, these materials can be certified by the manufacturer as clean and delivered to the site in protective wrapping. Samples of the filter pack, annular seal, and mixed grout should be retained as a quality control measure until at least one round of groundwater sampling and analysis is completed.

This section discusses material specifications for the following well construction components: casing, well screen, filter pack, annular sealant (bentonite pellets or chips), grout, tremie pipes, surface completion components (protective casing, lockable and water tight cap, and padlock), concrete surface pad, and uncontaminated water. Figure 2 shows the construction details of a typical monitoring well.

2.1.1 Casing Materials

The material type and minimum wall thickness of the casing should be adequate to withstand the forces of installation. If the casing has not been certified as clean by the manufacturer or delivered to and maintained in clean condition at the site, the casing should be steam cleaned or high-pressure water cleaned with water from a source of known chemistry immediately prior to installation (see Tetra Tech SOP No. 002). The ends of each casing section should be either flush-threaded or beveled for welding.

Schedule 40 or Schedule 80 PVC casing is typically used for monitoring well installation. Either type of casing is appropriate for monitoring wells with depths less than 100 feet below ground surface (bgs). If the well is deeper than 100 feet bgs, Schedule 80 PVC should be used.

Stainless steel used for well casing is typically Type 304 and is of 11-gauge thickness.

2.1.2 Well Screen Materials

Well screens should be new, machine-slotted or continuous wrapped wire-wound, and composed of materials most suited for the monitoring environment based on site characterization findings. Well screens are generally constructed of the same materials used for well casing (PVC or stainless steel). The screen should be plugged at the bottom with the same material as the well screen. Alternatively, a short (1- to 2-foot) section of casing material with a bottom (sump) should be attached below the screen. This assembly must be able to withstand installation and development stresses without becoming dislodged or damaged. The length of the slotted area should reflect the interval to be monitored.

If the well screen has not been certified as clean by the manufacturer or delivered to and maintained in clean condition at the site, the screen should be steam cleaned or high-pressure water cleaned with water from a source of known chemistry immediately prior to installation (see Tetra Tech SOP No. 002).

The minimum internal diameter of the well screen should be chosen based on the particular application. A minimum diameter of 2 inches is usually needed to allow for the introduction and withdrawal of sampling devices. Typical monitoring well screen diameters are 2 inches and 4 inches.

The slot size of the well screen should be determined relative to (1) the grain size of particles in the aquifer to be monitored and (2) the gradation of the filter pack material.

Screen length and monitoring well diameter will depend on site-specific considerations such as intended well use, contaminants of concern, and hydrogeology. Some specific considerations include the following:

- Water table wells should have screens of sufficient length and diameter to monitor the water table and provide sufficient sample volume under high and low water table conditions.

- Wells with low recharge should have screens of sufficient length and diameter so that adequate sample volume can be collected.

- Wells should be screened over sufficiently short intervals to allow for monitoring of discrete migration pathways.

- Where light nonaqueous-phase liquids (LNAPL) or contaminants in the upper portion of a hydraulic unit are being monitored, the screen should be set so that the upper portion of the water-bearing zone is below the top of the screen.

- Where dense nonaqueous-phase liquids (DNAPL) are being monitored, the screen should be set within the lower portion of the water-bearing zone, just above a relatively impermeable lithologic unit.

- The screened interval should not extend across an aquiclude or aquitard.

- If contamination is known to be concentrated within a portion of a saturated zone, the screen should be constructed in a manner that minimizes the potential for cross-contamination within the aquifer.

- If downhole geophysical surveys are to be conducted, the casing and screen must be of sufficient diameter and constructed of the appropriate material to allow for effective use of the geophysical survey tools.

- If aquifer tests are to be conducted in a monitoring well, the slot size must allow sufficient flux to produce the required drawdown and recovery. The diameter of the well must be sufficient to house the pump and monitoring equipment, and allow sufficient water flux (in combination with the screen slot size) to produce the required drawdown or recovery.

2.1.3 Filter Pack Materials

The primary filter pack consists of a granular material of known chemistry and selected grain size and gradation. The filter pack is installed in the annulus between the well screen and the borehole wall. The grain size and gradation of the filter pack are selected to stabilize the hydrologic unit adjacent to the screen and to prevent formation material from entering the well during development. After development, a properly filtered monitoring well is relatively free of turbidity.

A secondary filter pack is a layer of material placed in the annulus directly above the primary filter pack and separates the filter pack from the annular sealant. The secondary filter pack should be uniformly graded fine sand, with 100 percent by weight passing through a No. 30 U.S. Standard sieve, and less than 2 percent by weight passing through a No. 200 U.S. Standard sieve.

2.1.4 Annular Sealant (Bentonite Pellets or Chips)

The materials used to seal the annulus may be prepared as a slurry or used as dry pellets, granules, or chips. Sealants should be compatible with ambient geologic, hydrogeologic, and climatic conditions and any man-induced conditions anticipated to occur during the life of the well.

Bentonite (sodium montmorillonite) is the most commonly used annular sealant and is furnished in sacks or buckets in powder, granular, pelletized, or chip form. Bentonite should be obtained from a commercial source and should be free of impurities that may adversely impact the water quality in the well. Pellets are compressed bentonite powder in roughly spherical or disk shapes. Chips are large, coarse, irregularly shaped units of bentonite. The diameter of the pellets or chips should be less than one-fifth the width of the annular space into which they will be placed in order to reduce the potential for bridging. Granules consist of coarse particles of unaltered bentonite, typically smaller than 0.2 inch in diameter. Bentonite slurry is prepared by mixing powdered or granular bentonite with water from a source of known chemistry.

2.1.5 Grouting Materials

The grout backfill that is placed above the bentonite annular seal is ordinarily liquid slurry consisting of either (1) a bentonite (powder, granules, or both) base and water, (2) a bentonite and Portland cement base and water, or (3) a Portland cement base and water. Often, bentonite-based grouts are used when flexibility is desired during the life of the well installation (for example, to accommodate freeze-thaw cycles). Cement- or bentonite-based grouts are often used when cracks in the surrounding geologic material must be filled or when adherence to rock units, or a rigid setting is desired.

Each type of grout mixture has slightly different characteristics that may be appropriate under various physical and chemical conditions. However, quick-setting cements containing additives are not recommended for use in monitoring well installation because additives may leach from the cement and influence the chemistry of water samples collected from the well.

2.1.6 Tremie Pipe

A tremie pipe is used to place the filter pack, annular sealant, and grouting materials into the borehole. The tremie pipe should be rigid, have a minimum internal diameter of 1.0 inch, and be made of PVC or steel. The length of the tremie pipe should be sufficient to extend to the full depth of the monitoring well.

2.1.7 Surface Completion and Protective Casing Materials

Protective casings that extend above the ground surface should be made of aluminum, steel, stainless steel, cast iron, or a structural plastic. The protective casing should have a lid with a locking device to prevent vandalism. Sufficient clearance, usually 6 inches, should be maintained between the top of the riser and the top of protective casing. A water-tight well cap should be placed on the top of the riser to seal the well from surface water infiltration in the event of a flood. A weep hole should be drilled in the casing a minimum of 6 inches above the ground surface to enable water to drain out of the annular space.

Flush-mounted monitoring wells (wells that do not extend above ground surface) require a water-tight protective cover of sufficient strength to withstand heavy traffic. The well riser should be fitted with a locking water-tight cap.

2.1.8 Concrete Surface Pad and Bumper Posts

A concrete surface pad should be installed around each well when the outer protective casing is installed. The surface pad should be formed around the well casing. Concrete should be placed into the formed pad and into the borehole (on top of the grout), typically to a depth of 1 to 3 feet bgs (depending on state, federal, and local regulations). The protective casing is then installed into the concrete. As a general guideline, if the well casing is 2 inches in diameter, the concrete pad should be 3 feet square and 4 inches thick. If the well casing is 4 inches in diameter, the pad should be 4 feet square and 6 inches thick. Round concrete pads are also acceptable.

The finished pad should be sloped so that drainage flows away from the protective casing and off the pad. The finished pad should extend at least 1 inch below grade. If the monitoring wells are located in high traffic areas, a minimum of three bumper posts should be installed around the pad to protect the well. Bumper posts, consisting of steel pipes 3 to 4 inches in diameter and at least 5 feet long, should be installed in a radial pattern around the protective casing, beyond the edges of the cement pad. The base of the bumper posts should be installed 2 feet bgs in a concrete footing; the top of the post should be capped or filled with concrete.

2.1.9 Uncontaminated Water

Water used in the drilling process, to prepare grout mixtures, and to decontaminate the well screen, riser, and annular sealant injection equipment, should be obtained from a source of known chemistry. The water should not contain constituents that could compromise the integrity of the monitoring well installation.

2.2 MONITORING WELL INSTALLATION PROCEDURES

This section describes the procedures used to install a single-cased monitoring well, with either temporary casing or hollow-stem augers to support the walls of the boring in unconsolidated formations. The procedures are described in the order in which they are conducted, and include: (1) placement of well screen and riser pipe, (2) placement of filter pack, (3) progressive retrieval of temporary casing, (4) placement of annular seal, (5) grouting, (6) surface completion and installation of protective casing, and (7) installation of concrete pad and bumper posts.

The additional steps necessary to install a well with permanent or multiple casing strings are described at the end of this section.

2.2.1 Well Screen and Riser Placement

After the total depth of the boring is confirmed and the well screen depth interval and the height of the aboveground completion are determined, the screen and riser is assembled from the bottom up as it is lowered down the hole. The following procedures should be followed:

1. Measure the total depth of the boring using a weighted tape.
2. Determine the length of screen and casing materials required to construct the well.
3. Assemble the well parts from the bottom up, starting with the well sump or cap, well screen, and then riser pipe. Progressively lower the assembled length of pipe.
4. The length of the assembled pipe should not extend above the top of the installation rig.

The well sump or cap, well screen, and riser should be certified clean by the manufacturer or should be decontaminated before assembly and installation. No grease, oil, or other contaminants should contact any portion of the assembly. Flush joints should be tightened, and welds should be water tight and of good quality. The riser should extend above grade and be capped temporarily to prevent entrance of foreign materials during the remaining well completion procedures.

When the well screen and riser assembly is lowered to the predetermined level, it may float and require a method to hold it in place. For borings drilled using cable tool or air rotary drilling methods, centralizers should be attached to the riser at intervals of between 20 and 40 feet.

2.2.2 Filter Pack Placement

The filter pack is placed after the well screen and riser assembly has been lowered into the borehole. The steps below should be followed:

1. Determine the volume of the annular space in the filter pack interval. The filter pack should extend from the bottom of the borehole to at least 2 feet above the top of the well screen.

2. Assemble the required material (sand pack and tremie pipe).

3. Lower a clean or decontaminated tremie pipe down the annulus to within 1 foot of the base of the hole.

4. Pour the sand down the tremie pipe using a funnel; pour only the quantity estimated to fill the first foot.

5. Check the depth of sand in the hole using a weighted tape.

6. Pull the drill casing up ahead of the sand to keep the sand from bridging.

7. Continue with this process (steps 4 through 6) until the filter pack is at the appropriate depth.

If bridging of the filter pack occurs, break out the bridge prior to adding additional filter pack material. For wells less than 30 feet deep installed inside hollow-stem augers, the sand may be poured in 1-foot lifts without a tremie pipe.

Sufficient measurements of the depth to the filter pack material and the depth of the bottom of the temporary casing should be made to ensure that the casing bottom is always above the filter pack. The filter pack should extend 2 feet above the well screen (or more if required by state or local regulations). However, the filter pack should not extend across separate hydrogeologic units. The final depth interval, volume, and type of filter pack should be recorded on the Monitoring Well Completion Record (Figure 1).

A secondary filter pack may be installed above the primary filter pack to prevent the intrusion of the bentonite grout seal into the primary filter pack. A measured volume of secondary filter material should be added to extend 1 to 2 feet above the primary filter pack. As with the primary filter pack, a secondary filter pack must not extend into an overlying hydrologic unit. An on-site geologist should evaluate the need for a secondary filter pack by considering the gradation of the primary filter pack, the hydraulic head difference between adjacent units, and the potential for grout intrusion into the primary filter pack.

The secondary filter material is poured into the annular space through tremie pipe as described above. Water from a source of known chemistry may be added to help place the filter pack into its proper location.

The tremie pipe or a weighed line inserted through the tremie pipe can be used to measure the top of the secondary filter pack as work progresses. The amount and type of secondary filter pack used should be recorded on the Monitoring Well Completion Record (Figure 1).

2.2.3 Temporary Casing Retrieval

The temporary casing or hollow-stem auger should be withdrawn in increments. Care should be taken to minimize lifting the well screen and riser assembly during withdrawal of the temporary casing or auger. It may be necessary to place the top head of the rig on the riser to hold it down. To limit borehole collapse in formations consisting of unconsolidated materials, the temporary casing or hollow-stem auger is usually withdrawn until the lowest point of the casing or auger is at least 2 feet, but no more than 5 feet, above the filter pack. When the geologic formation consists of consolidated materials, the lowest point of the casing or auger should be at least 5 feet, but no more than 10 feet, above the filter pack. In highly unstable formations, withdrawal intervals may be much less. After each increment, the depth to the primary filter pack should be measured to check that the borehole has not collapsed or that bridging has not occurred.

2.2.4 Annular Seal Placement

A bentonite pellet, chip, or slurry seal should be placed between the borehole and the riser on top of the primary or secondary filter pack. This seal retards the movement of grout into the filter pack. The thickness of the bentonite seal will depend on state and local regulations, but the seal should generally be between 3 and 5 feet thick.

The bentonite seal should be installed using a tremie pipe, lowered to the top of the filter pack and slowly raised as the bentonite pellets or slurry fill the space. Care must be taken so that bentonite pellets or chips do not bridge in the augers or tremie pipe. The depth of the seal should be checked with a weighted tape or the tremie pipe.

If a bentonite pellet or chip seal is installed above the water level, water from a known source should be added to allow proper hydration of the bentonite. Sufficient time should be allowed for the bentonite seal to hydrate. The volume and thickness of the bentonite seal should be recorded on the Monitoring Well Completion Record (Figure 1).

2.2.5 Grouting

Grouting procedures vary with the type of well design. The volume of grout needed to backfill the remaining annular space should be calculated and recorded on the Monitoring Well Completion Record (Figure 1). The use of alternate grout materials, including grouts containing gravel, may be necessary to control zones of high grout loss. Bentonite grouts should not be used in arid regions because of their propensity to desiccate. Typical grout mixtures include the following:

- Bentonite grout: about 1 to 1.25 pounds of bentonite mixed with 1 gallon of water
- Cement-bentonite grout: about 5 pounds of bentonite and one 94-pound bag of cement mixed with 7 to 8 gallons of water
- Cement grout: one 94-pound bag of cement mixed with 6 to 7 gallons of water

The grout should be installed by gravity feed through a tremie pipe. The grout should be mixed in batches in accordance with the appropriate requirements and then pumped into the annular space until full-strength grout flows out at the ground surface without evidence of drill cuttings or fluid. The tremie pipe should then be removed to allow the grout to cure.

The riser should not be disturbed until the grout sets and cures for the amount of time necessary to prevent a break in the seal between the grout and riser. For bentonite grouts, curing times are typically around 24 hours; curing times for cement grouts are typically 48 to 72 hours. However, the curing time required will vary with grout content and climatic conditions. The curing time should be documented in the Monitoring Well Completion Record (Figure 1).

2.2.6 Surface Completion and Protective Casing

Aboveground completion of the monitoring well should begin once the grout has set (no sooner than 24 hours after the grout was placed). The protective casing is lowered over the riser and set into the cured grout. The protective casing should extend below the ground surface to a depth below the frost line (typically 3 to 5 feet, depending on local conditions). The protective casing is then cemented in place. A minimum of 6 inches of clearance should be maintained between the top of the riser and the protective casing. A 0.5-inch diameter drainage or weep hole should be drilled in the protective casing approximately

6 inches above the ground surface to enable water to drain out of the annular space between the casing and riser. A water-tight cap should be placed on top of the riser to seal the well from surface water infiltration in the event of a flood. A lock should be placed on the protective casing to prevent vandalism.

For flush-mounted monitoring wells, the well cover should be raised above grade and the surrounding concrete pad sloped so that water drains away from the cover. The flush-mount completion should be installed in accordance with applicable state and local regulations.

2.2.7 Concrete Surface Pad and Bumper Posts

The concrete pad installed around the monitoring well should be sloped so that the drainage will flow away from the protective casing and off the pad. The finished pad should extend at least 1 inch below grade. If the monitoring wells are located in high traffic areas, a minimum of three bumper posts should be installed in a radial pattern around the protective casing, outside the cement pad. Specifications for concrete surface pads and bumper posts are described in Section 2.1.8.

2.2.8 Permanent and Multiple Casing Well Installation

When wells are installed through multiple saturated zones, special well construction methods should be used to assure well integrity and limit the potential for cross-contamination between geologic zones. Generally, these types of wells are necessary if relatively impermeable layers separate hydraulic units. Two procedures that may be used are described below.

In the first procedure, the borehole is advanced to the base of the first saturated zone. Casing is then anchored in the underlying impermeable layer (aquitard) by advancing the casing at least 1 foot into the aquitard and grouting to the surface. After the grout has cured, a smaller diameter borehole is drilled through the grout. This procedure is repeated until the zone of interest is reached. After the zone is reached, a conventional well screen and riser are set. A typical well constructed in this manner is shown on Figure 3.

A second acceptable procedure involves driving a casing through several saturated layers while drilling ahead of the casing. However, this method is not acceptable when the driven casing may structurally damage a competent aquitard or aquiclude and result in cross-contamination of the two saturated layers. This method should also be avoided when highly contaminated groundwater or nonaqueous-phase contamination may be dragged down into underlying uncontaminated hydrologic units.

2.3 RECORDKEEPING PROCEDURES

Recordkeeping procedures associated with monitoring well installation are described in the following sections. These include procedures for surveying, obtaining permits, completing well construction records, and identifying monitoring wells.

2.3.1 Surveying

Latitude, longitude, and elevation at the top of the riser should be determined for each monitoring well. A permanent notch or black mark should be made on the north side of the riser. The top of the riser and ground surface should be surveyed.

2.3.2 Permits and Well Construction Records

Local and state regulations should be reviewed prior to monitoring well installation, and any required well permits should be in-hand before the driller is scheduled.

Monitoring well installation activities should be documented in both the field logbook and on the Monitoring Well Completion Record (Figure 1). Geologic logs should be completed and, if necessary, filed with the appropriate regulatory agency within the appropriate time frame.

2.3.3 Monitoring Well Identification

Each monitoring well should have an individual well identification number or name. The well identification may be stamped in the metal surface upon completion or permanently marked by using another method. Current state and local regulations should be checked for identification requirements (such as township, range, section, or other identifiers in the well name).

FIGURE 1

MONITORING WELL COMPLETION RECORD

TETRATECH EM INC

MONITORING WELL COMPLETION RECORD

MONITORING WELL

MONITORING WELL NO.: ________
PROJECT: ________
SITE: ________
BOREHOLE NO.: ________
WELL PERMIT NO.: ________
TOC TO BOTTOM OF WELL: ________

DRILLING INFORMATION

DRILLING BEGAN:
DATE: ________ TIME: ________
WELL INSTALLATION BEGAN:
DATE: ________ TIME: ________
WELL INSTALLATION FINISHED:
DATE: ________ TIME: ________
DRILLING CO.: ________
DRILLER: ________
LICENSE: ________
DRILL RIG: ________
DRILLING METHOD:
❑ HOLLOW-STEM AUGER
❑ AIR ROTARY
❑ OTHER: ________
DIAMETER OF AUGERS:
ID: ________ OD: ________

WELL CASING

❑ SCHEDULE 40 PVC
❑ OTHER: ________
PRODUCT: ________
MFG. BY: ________
CASING DIAMETER:
ID: ________ OD: ________
LENGTH OF CASING: ________

WELL SCREEN

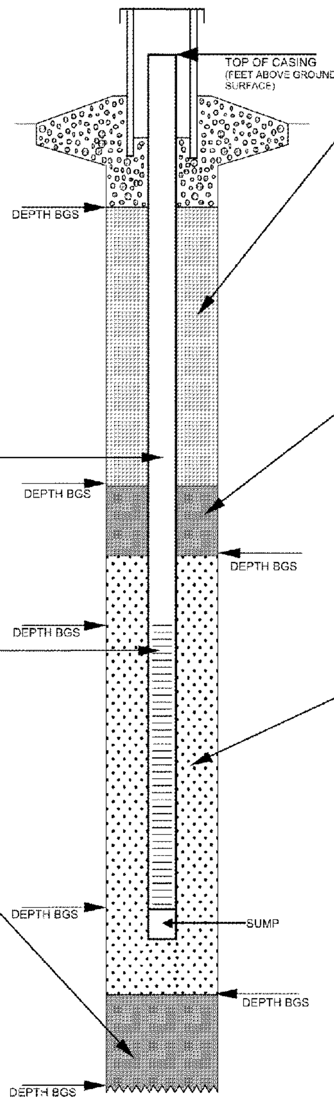
❑ SCHEDULE 40 PVC
❑ OTHER: ________
PRODUCT: ________
MFG. BY: ________
CASING DIAMETER:
ID: ________ OD: ________
SLOT SIZE: ________
LENGTH OF SCREEN: ________

BOREHOLE BACKFILL

AMOUNT CALCULATED: ________
AMOUNT USED: ________
❑ BENTONITE CHIPS, SIZE: ________
❑ BENTONITE PELLETS, SIZE: ________
❑ SLURRY: ________
❑ FORMATION COLLAPSE: ________
❑ OTHER: ________
PRODUCT: ________
MFG. BY: ________
METHOD INSTALLED:
❑ POURED ❑ TREMIE
❑ OTHER: ________

SURFACE COMPLETION

❑ FLUSH MOUNT
❑ ABOVE GROUND WITH BUMPER POST
❑ CONCRETE ❑ ASPHALT



SURVEY INFORMATION

TOC ELEVATION: ________
GROUND SURFACE ELEVATION: ________
NORTHING: ________
EASTING: ________
DATE SURVEYED: ________
SURVEY CO.: ________

ANNULAR SEAL

VOLUME CALCULATED: ________
AMOUNT USED: ________
❑ GROUT FORMULA (PERCENTAGES)
PORTLAND CEMENT: ________
BENTONITE: ________
WATER: ________
❑ PREPARED MIX
PRODUCT: ________
MFG. BY: ________
METHOD INSTALLED:
❑ POURED ❑ TREMIE
❑ OTHER: ________

BENTONITE SEAL

VOLUME CALCULATED: ________
AMOUNT USED: ________
❑ PELLETS, SIZE: ________
❑ CHIPS, SIZE: ________
❑ OTHER: ________
PRODUCT: ________
MFG. BY: ________
METHOD INSTALLED:
❑ POURED ❑ TREMIE
❑ OTHER: ________
AMOUNT OF WATER USED: ________

FILTER PACK

❑ PREPACKED FILTER
VOLUME CALCULATED: ________
AMOUNT USED: ________
❑ SAND, SIZE: ________
PRODUCT: ________
MFG. BY: ________
METHOD INSTALLED:
❑ POURED ❑ TREMIE
❑ OTHER: ________
WATER LEVEL: ________
(BTOC AFTER WELL INSTALLATION)

CENTRALIZERS USED?

❑ YES ❑ NO;
CENTRALIZER DEPTHS: ________ ________

LEGEND

BGS = BELOW GROUND SURFACE
BTOC = BELOW TOP OF CASING
N/A = NOT APPLICABLE
NR = NOT RECORDED
TOC = TOP OF CASING
ID = INSIDE DIAMETER
OD = OUTSIDE DIAMETER

FIGURE 2

MONITORING WELL CONSTRUCTION DIAGRAM

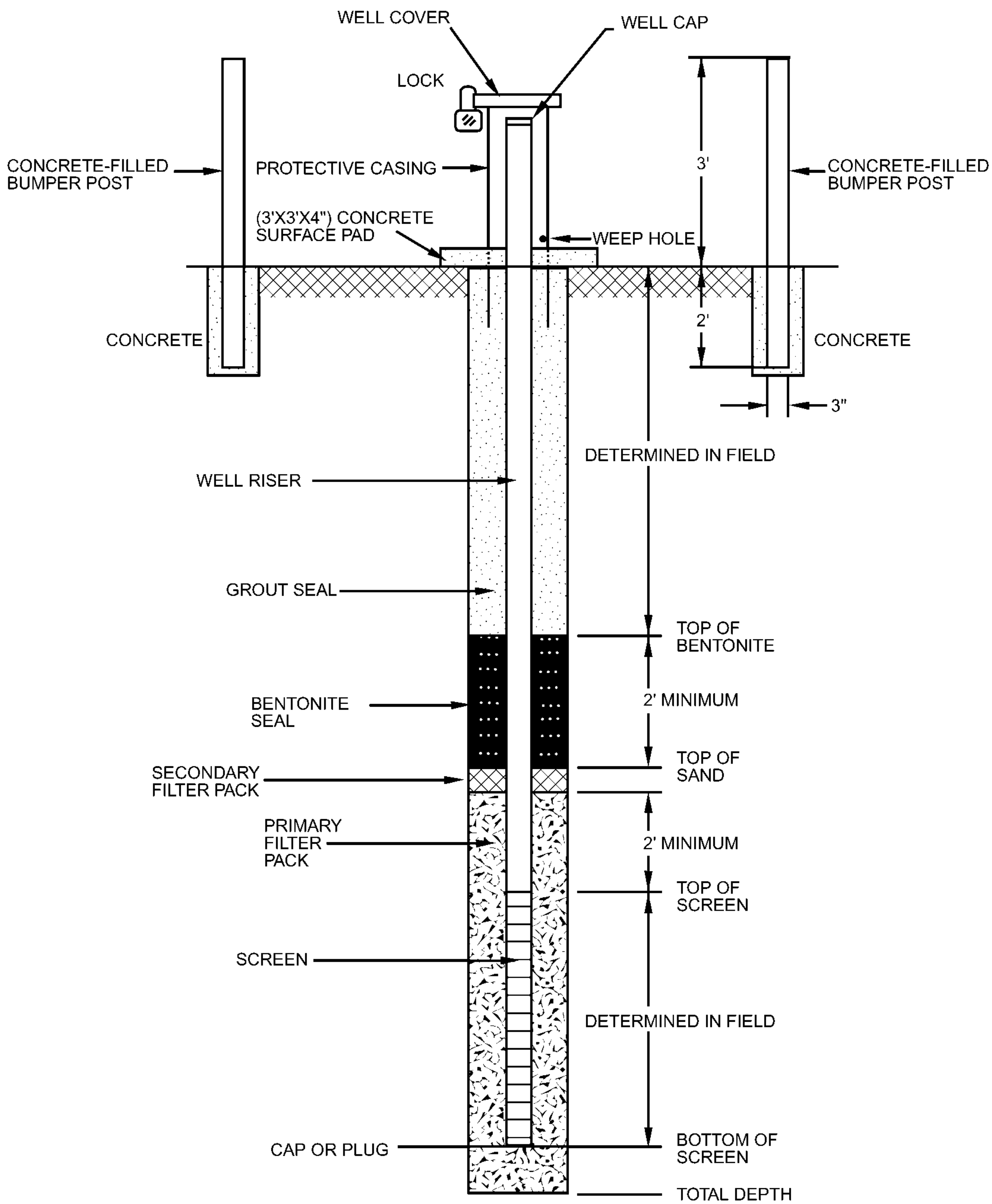
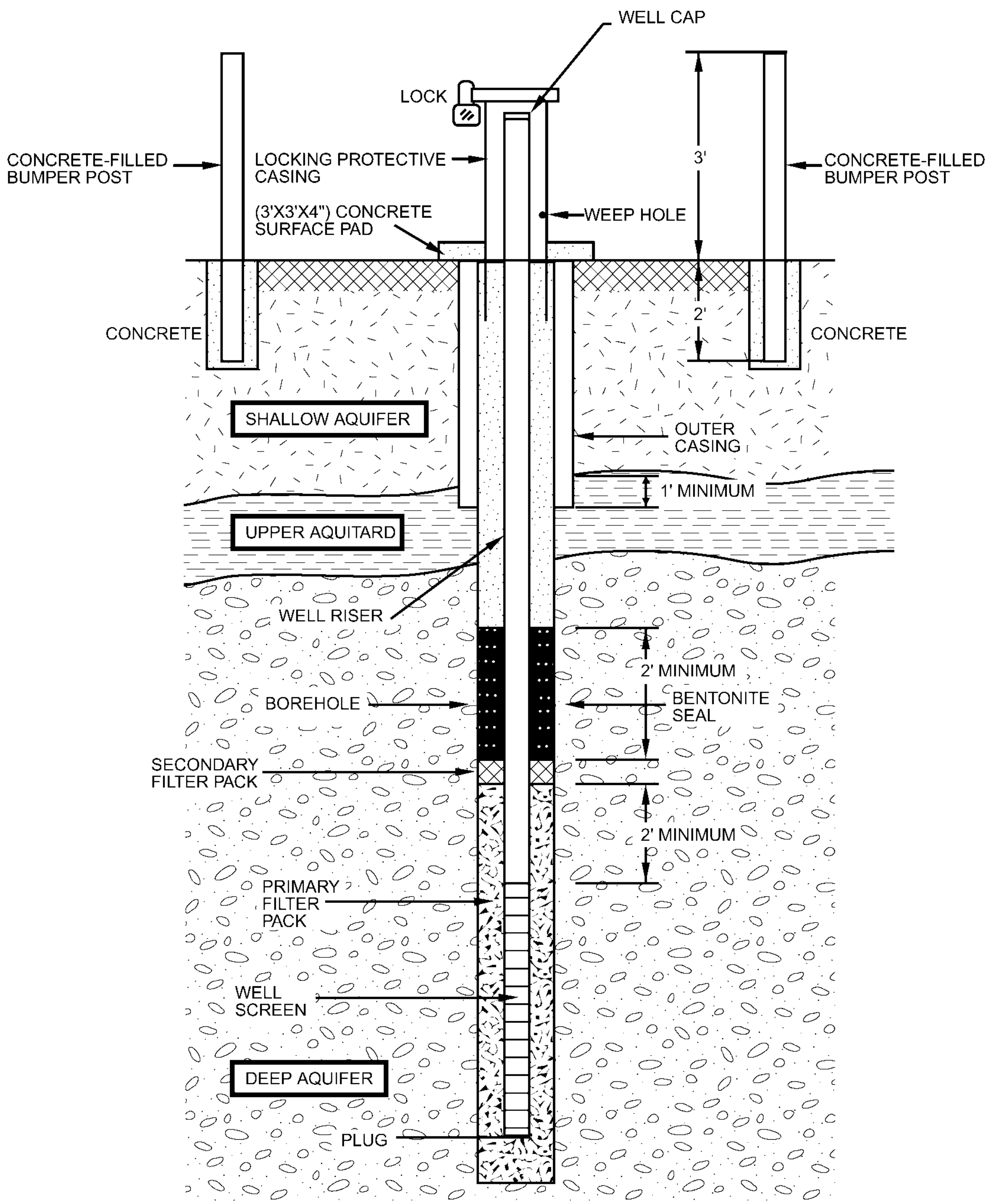


FIGURE 3

MULTIPLE CASING WELL CONSTRUCTION DIAGRAM



SOP APPROVAL FORM

TETRA TECH EM INC.

ENVIRONMENTAL STANDARD OPERATING PROCEDURE

MONITORING WELL DEVELOPMENT

SOP NO. 021

REVISION NO. 3

Last Reviewed: October 2000

Quality Assurance Approved

October 5, 2000

Date

1.0 BACKGROUND

All drilling methods impair the ability of an aquifer to transmit water to a drilled hole. This impairment is typically a result of disturbance of soil grains (smearing) or the invasion of drilling fluids or solids into the aquifer during the drilling process. The impact to the hydrologic unit surrounding the borehole must be remediated so that the well hydraulics and samples collected from the monitoring well are representative of the aquifer.

Well development should be conducted as an integral step of monitoring well installation to remove the finer-grained material, typically clay and silt, from the geologic formation near the well screen and filter pack. (Monitoring well installation is discussed in standard operating procedure [SOP] No. 020.) The fine-grained particles may interfere with water quality analyses and alter the hydraulic characteristics of the filter pack and the hydraulic unit adjacent to the well screen. Well development improves the hydraulic connection between water in the well and water in the formation. The most common well development methods are surging, jetting, overpumping, and bailing.

The health and safety plan for the site should be followed to avoid exposure to chemicals of concern. Water, sediment, and other waste removed from a monitoring well should be disposed of in accordance with applicable federal, state, and local requirements.

1.1 PURPOSE

This SOP establishes the requirements and procedure for monitoring well development. Well development improves the hydraulic characteristics of the filter pack and borehole wall by performing the following functions:

- Reducing the compaction and the intermixing of grain sizes produced during drilling by removing fine material from the pore spaces.
- Removing the filter cake or drilling fluid film that coats the borehole as well as much or all of the drilling fluid and natural formation solids that have invaded the formation.
- Creating a graded zone of sediment around the screen, thereby stabilizing the formation so that the well can yield sediment-free water.

1.2 SCOPE

This SOP applies to the development of newly installed monitoring wells. The SOP identifies the most commonly used well development methods; these methods can be used individually or in combination to achieve the most effective well development. Selection of a particular method will depend on site conditions, equipment limitations, and other factors. The method selected and the rationale for selection should be documented in a field logbook or appropriate project reports.

1.3 DEFINITIONS

Aquifer: A geologic formation, group of formations, or part of a formation that is saturated and capable of storing and transmitting water.

Aquitard: a geologic formation, group of formations, or part of a formation through which virtually no water moves.

Bailer: A cylindrical sampling device with valves on either end, used to extract water from a well or borehole.

Bentonite seal: A colloidal (extremely fine particle that will not settle out of solution) clay seal separating the sand pack from the surface seal.

Drilling fluid: A fluid (liquid or gas) that may be used in drilling operations to remove cuttings from the borehole, to clean and cool the drill bit, and to maintain the integrity of the borehole during drilling.

Filter pack: A clean, uniform sand or gravel placed between the borehole wall and the well screen to prevent formation material from entering the screen.

Grout seal: A fluid mixture of (1) cement and water or (2) cement, bentonite, and water that is placed above the bentonite seal between the casing and the borehole wall to secure the casing in place and keep water from entering the borehole.

Hydraulic conductivity: A measure of the ease with which water moves through a geologic formation. Hydraulic conductivity, K, is typically measured in units of distance per time in the direction of groundwater flow.

Hydrologic units: Geologic strata that can be distinguished on the basis of capacity to yield and transmit fluids. Aquifers and confining units are types of hydrologic units.

Oil air filter: A filter or series of filters placed in the airflow line from an air compressor to reduce the oil content of the air.

Oil trap: A device used to remove oil from the compressed air discharged from an air compressor.

Riser: The pipe extending from the well screen to or above the ground surface.

Specific conductance: A measure of the ability of the water to conduct an electric current. Specific conductance is related to the total concentration of ionizable solids in the water and is inversely proportional to electrical resistance.

Static water level: The elevation of the top of a column of water in a monitoring well or piezometer that is not influenced by pumping or conditions related to well installation, hydrologic testing, or nearby pumpage.

Transmissivity: The volume of water transmitted per unit width of an aquifer over the entire thickness of the aquifer flow, under a unit hydraulic gradient.

Well screen: A cylindrical pipe with openings of a uniform width, orientation, and spacing used to keep materials other than water from entering the well and to stabilize the surrounding formation.

Well screen jetting (hydraulic jetting): A jetting method used for development; nozzles and a high pressure pump are used to force water outwardly through the screen, the filter pack, and sometimes into the adjacent geologic unit.

1.4 REFERENCES

American Society for Testing and Materials. 1990. Standard Practice for Design and Installation of Ground Water Monitoring Wells in Aquifers. D5092-90. West Conshohocken, Pennsylvania.

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EPA. 1994. Well Development. Environmental Response Team SOP #2044 (Rev. #0.0, 10/03/94). On-Line Address: http://www.ert.org/media_resrcs/media_resrcs.asp?Child1=

1.5 REQUIREMENTS AND RESOURCES

The type of equipment used for well development will depend on the well development method. Well development methods and the equipment required are discussed in Section 2.1 of this SOP. In general, monitoring wells should be developed shortly after they are installed but no sooner than 24 hours after the placement of the grout seal, depending on the grout cure rate and well development method. Most drilling or well development rigs have pumps, air compressors, bailers, surge blocks, and other equipment that can be used to develop a monitoring well.

All downhole equipment should be properly decontaminated before and after each well is developed. See SOP No. 002 (General Equipment Decontamination) for details.

2.0 WELL DEVELOPMENT PROCEDURES

This section describes common well development methods, factors to be considered in selecting a well development method, procedures for initiating well development, well development duration, and calculations typically made during well development. In addition to this, procedures described in any work plans for well development should be fully consistent with local and state regulations and guidelines.

2.1 WELL DEVELOPMENT METHODS

Well development methods vary with the physical characterization of hydrologic units in which the monitoring well is screened and the drilling method used. The most common methods include mechanical surging, overpumping, air lift pumping, backwashing, surge bailing, and well jetting. These methods may be effective alone or may need to be combined (for example, overpumping combined with backwashing). Factors such as well design and hydrogeologic conditions will determine which well development method will be most practical and cost-effective. Commonly used well development methods are described in Sections 2.1.1 through 2.1.6.

The use of chemicals for monitoring well development should be avoided as much as possible. Introduction of chemicals may significantly alter groundwater chemistry in and around the well.

2.1.1 Mechanical Surging

The mechanical surging method forces water to flow in and out of the well screen by operating a plunger (or surge block) in the casing, similar to a piston in a cylinder. A typical surge block is shown in Figure 1. The surge block should fit snugly in the well casing to increase the surging action. The surge block is attached to a drill rod or drill stem and is of sufficient weight to cause the block to drop rapidly on the down stroke, forcing water contained in the borehole into the aquifer surrounding the well. In the recovery stroke or upstroke, water is lifted by the surge block, allowing water and fine sediments to flow back into the well from the aquifer. Down strokes and recovery strokes are usually 3 to 5 feet in length.

The surge block should be lowered into the water column above the well screen. The water column will effectively transmit the action of the block to the filter pack and hydrologic unit adjacent to the well screen. Development should begin above the screen and move progressively downward to prevent the surge block from becoming sand locked in the well. The initial surging action should be relatively gentle, allowing any material blocking the screen to break up, go into suspension, and then move into the well. As water begins to move easily both in and out of the screen, the surge block is usually lowered in increments to a level just above the screen. As the block is lowered, the force of the surging movement should be increased. In wells equipped with long screens, it may be more effective to operate the surge block in the screen to concentrate its actions at various levels.

A pump or bailer should be used periodically to remove dislodged sediment that may have accumulated at the bottom of the well during the surging process. The pump or bailer should be moved up and down at the bottom of the well to suspend and collect as much sediment as possible.

The accumulation of material developed from a specific screen interval can be measured by sounding the total depth of the well before and after surging. Continue surging until little or no sand accumulates.

2.1.2 Overpumping

Overpumping involves pumping the well at a rate substantially higher than it will be pumped during well purging and groundwater sampling. This method is most effective on coarse-grained formations and is usually conducted in conjunction with mechanical surging or backwashing. Overpumping is commonly implemented using a submersible pump. In cases were the water table is less than 30 feet from the top of the casing, it is possible to overpump the well with a centrifugal pump. The intake pipe is lowered into the water column at a depth sufficient to ensure that the water in the well is not drawn down to the pump intake level. The inflow of water at the well screen is not dependent on the location of the pump intake as long as it remains submerged.

Overpumping will induce a high velocity water flow, resulting in the flow of sand, silt, and clay into the well, opening clogged screen slots and cleaning formation voids and fractures. The movement of these particles at high flow rates should eliminate particle movement at the lower flow rates used during well purging and sampling. The bridging of particles against the screen because of the flow rate and direction created by overpumping may be overcome by using mechanical surging or backwashing in conjunction with this method.

2.1.3 Air Lift Pumping

Air lift pumping uses a two-pipe system consisting of an air injection pipe and a discharge pipe. In this well development method, an air lift pump is operated by cycling the air pressure on and off for short periods of time. This operation provides a surging action that can dislodge fine-grained particles in the vicinity of the well screen. Subsequently applying a steady low pressure removes the fines drawn into the well by the surging action.

The bottom of the air lift should be at least 10 feet above the top of the well screen. Air is injected through an inner pipe at sufficient pressure to bubble out directly into the surrounding discharge pipe. The bubbles formed by the injected air cause the column of water in the discharge pipe to be lifted upward and allow water from the aquifer to flow into the well. This arrangement prevents injected air from entering the well screen. Pumping air through the well screen and into the filter pack and adjacent hydrologic unit should be avoided because it can cause air entrainment, inhibiting future sampling efforts and possibly altering groundwater chemistry.

The air injected into the well should be filtered using an oil/air filter and oil trap to remove any compressor lubricant entrained in the air. Air pressures required for this well development method are relatively low; an air pressure of 14.8 pounds per square inch should move a 30-foot column of water. For small-diameter, shallow wells where the amount of development water is likely to be limited, tanks of inert gas (such as nitrogen) can be used as an alternative to compressed air.

2.1.4 Backwashing

Effective development procedures should cause flow reversals through the screen openings that will agitate the sediment, remove the finer fraction, and then rearrange the remaining formation particles. Backwashing overcomes the bridging that results from overpumping by allowing the water that is pumped to the top of the well to flow back through the submersible pump and out through the well screen. The backflow portion of the backwashing cycle breaks down bridging, and the inflow then moves the fine material toward the screen and into the well.

Some wells respond satisfactorily to backwashing techniques, but the surging effect is not vigorous enough to obtain maximum results in many cases.

A variation of backwashing may be effective in low-permeability formations. After the filter pack is installed on a monitoring well, clean water is circulated down the well casing, out through the well screen and filter pack, and up through the open borehole before the grout or bentonite seal is placed in the annulus. Flow rates should be controlled to prevent floating the filter pack. Because of the low hydraulic conductivity of the formation, negligible amounts of water will infiltrate into the formation. Immediately after this procedure, the bentonite seal should be installed, and the nonformation water should be pumped out of the well and filter pack.

2.1.5 Surge Bailing

Surge bailing can be an effective well development method in relatively clean, permeable formations where water flows freely into the borehole. A bailer made of stainless steel or polyvinyl chloride and slightly smaller than the well casing diameter is allowed to fall freely through the borehole until it strikes the groundwater surface. The contact of the bailer produces a downward force and causes water to flow outward through the well screen, breaking up bridging that has developed around the screen. As the bailer fills and is rapidly withdrawn from the well, the drawdown created causes fine particles to flow through the well screen and into the well. Subsequent bailing can remove these particles from the well. Lowering the bailer to the bottom of the well and using rapid short strokes to agitate and suspend solids that have settled to the well bottom can enhance removal of sand and fine particles. Bailing should continue until the water is free of suspended particles.

2.1.6 Well Jetting

Well jetting can be used to develop monitoring wells in both unconsolidated and consolidated formations. Water jetting can open fractures and remove drilling mud that has penetrated the aquifer. The discharge force of the jetting tool is concentrated over a small area of the well screen. As a result, the tool must be rotated constantly while it is raised and lowered in a very small increments to be sure that all portions of the screen are exposed to the jetting action.

Jetting is relatively ineffective on the fine screens typically used in monitoring wells (slot sizes from 0.01 to 0.02 inch). In addition, jetting requires the introduction of external water into the well and surrounding formation. This water should be obtained from a source of known chemistry. Water introduced for development should be completely removed from the aquifer immediately after development.

The use of compressed air as a jetting agent should not be employed for development of monitoring wells. Compressed air could entrain air in the formation, introduce oil into the formation, and damage the well screen.

2.2 FACTORS TO CONSIDER WHEN SELECTING A WELL DEVELOPMENT METHOD

It is important to check federal, state, and local regulatory requirements for monitoring well development requirements. This SOP may be changed to accommodate applicable regulations, site conditions, or equipment limitations.

The type of geologic material, the design and completion of the well, and the type of drilling method used are all factors to be considered during the development of a monitoring well.

Monitoring well development should usually be started slowly and gently and then performed with increasing vigor as the well is developed. Most well development methods require the application of sufficient energy to disturb the filter pack, thereby freeing fine particles and allowing them to be drawn into the well. The coarser particles then settle around and stabilize the screen.

Development procedures for wells completed in fine sand and silt strata should involve methods that are relatively gentle so that strata material will not be incorporated into the filter pack. Vigorous surging for development can produce mixing of the fine strata and filter pack and produce turbid samples from the formation. In addition, development methods should be carefully selected based upon the potential contaminants present, the quantity of wastewater generated, and requirements for containerization or treatment of wastewater.

For small diameter and small volume wells, a development bailer can be used in place of a submersible pump in the pumping method. Similarly, a bailer can be used in much the same fashion as a surge block in small diameter wells.

Any time an air compressor is used for well development, it should be equipped with an oil air filter or oil trap to minimize the introduction of oil into the screened area. The presence of oil could impact the organic constituent concentrations of the water samples collected from the well.

The presence of light nonaqueous phase liquid (LNAPL) can impact monitoring well development. Water jetting or vacuum-enhanced well development may assist in breaking down the smear zone in the LNAPL. Normal development procedures are conducted in the water-saturated zone and do not affect the LNAPL zone.

2.3 INITIATING WELL DEVELOPMENT

Newly completed monitoring wells should be developed as soon as practical, but no sooner than 24 hours after grouting is completed if rigorous well development methods are used. Development may be initiated shortly after well installation if the development method does not interfere with the grout seal. State and local regulations should be checked for guidance. The following general well development steps can be used with any of the methods described in Section 2.1.

1. Assemble the necessary equipment on a plastic sheet around the well. This may include a water level meter (or oil/water interface probe if LNAPL or dense nonaqueous phase liquid is present); personal protective equipment; pH, conductivity, temperature, and turbidity meters; air monitoring equipment; Well Development Data Sheets (see Figure 2); a watch; and a field logbook.

2. Open the well and take air monitoring readings at the top of the well casing and in the breathing zone. See SOP No. 003 (Organic Vapor Air Monitoring) for additional guidance.

3. Measure the depth to water and the total depth of the monitoring well. See SOP No. 014 (Static Water Level, Total Well Depth, and Immiscible Layer Measurement) for additional guidance.

4. Measure the initial pH, temperature, turbidity, and specific conductance of the groundwater from the first groundwater that comes out of the well. Note the time, initial color, clarity, and odor of the water. Record the results on a Well Development Data Sheet (see Figure 2) or in a field logbook. See SOPs No. 011 (Field Measurement of Water Temperature), 012 (Field Measurement of pH), 013 (Field Measurement of Specific Conductance), and 088 (Field Measurement of Water Turbidity) for additional guidance.

5. Develop the well using one or more of the methods described in Section 2.1 until the well is free of sediments and the groundwater turbidity has reached acceptable levels. Record the development method and other pertinent information on a Well Development Data Sheet see Figure 2) or in a field logbook.

6. Containerize any groundwater produced during well development if groundwater contamination is suspected. The containerized water should be sampled and analyzed to determine an appropriate disposal method.

7. Do not add water to assist in well development unless the water is from a source of known chemical quality and the addition has been approved by the project manager. If water is added, five times the amount of water introduced should be removed during development.

8. Continue to develop the well, repeating the water quality measurements for each borehole volume. Development should continue until each water quality parameter is stable to within 10 percent. Development should also continue until all the water added during development (if any) is removed or the water has a turbidity of less than 50 nephelometric turbidity units. This level may only be attainable after allowing the well to settle and testing at low flow sampling rates.

9. At the completion of well development, measure the final pH, temperature, turbidity, and specific conductance of the groundwater. Note the color, clarity, and odor of the water. Record the results on a Well Development Data Sheet (see Figure 2) or in a field logbook. In addition to the final water quality parameters, the following data should be noted on the Well Development Data Sheet: well identification, date(s) of well installation, date(s) and time of well development, static water level before and after development, quantity of water removed and time of removal, type and capacity of pump or bailer used, and well development technique.

All contaminated water produced during development should be containerized in drums or storage vessels properly labeled with the date collected, generating address, well identification, and consultant contact number.

2.4 DURATION OF WELL DEVELOPMENT

Well development should continue until representative water, free of the drilling fluids, cuttings, or other materials introduced during well construction is obtained. When pH, temperature, turbidity, and specific conductance readings stabilize and the water is visually clear of suspended solids, the water is representative of formation water. The minimum duration of well development should vary in accordance with the method used to develop the well. For example, surging and pumping the well may provide a stable, sediment free sample in a matter of minutes, whereas bailing the well may require several hours of continuous effort to obtain a clear sample.

An on-site project geologist should make the final decision as to whether well development is complete. This decision should be documented on a Well Development Data Sheet (see Figure 2) or in a field logbook.

2.5 CALCULATIONS

It is necessary to calculate the volume of water in the well. Monitoring well diameters are typically 2, 3, 4, or 6 inches. The height of water column (in feet) in the well can be multiplied by the following conversion factors to calculate the volume of water in the well casing.

Well Diameter (inches)	Volume (gallon per foot)
2	0.1631
3	0.3670
4	0.6524
6	1.4680

3.0 POTENTIAL PROBLEMS

The following potential problems can occur during development of monitoring wells:

- In some wells the pH, temperature, and specific conductance may stabilize but the water remains turbid. When this occurs, the well may still contain construction materials (such as drilling mud in the form of a mud cake) and formation soils that have not been washed out of the borehole. Excessive or thick drilling muds cannot be flushed out of a borehole with one or two well volumes of flushing. Continuous flushing over a period of several days may be necessary to complete well development. If the well is completed in a silty zone, it may be necessary to sample with low flow methods or filtering.

- Mechanical surging and well jetting disturb the formation and filter pack more than other well development methods. In formations with high clay and silt contents, surging and jetting can cause the well screen to become clogged with fines. If an excessive amount of fines is produced, sand locking of the surge block may result. Well development with these methods should be initiated gently to minimize disturbance of the filter pack and to prevent damage to the well screen.

- Effective overpumping may involve the discharge of large amounts of groundwater. This method is not recommended when groundwater extracted during well development is contaminated with hazardous constituents. If the hazardous constituents are organic compounds, this problem can be partially overcome by passing the groundwater through an activated carbon filter.

- When a well is developed by mechanical surging or bailing, rapid withdrawal of the surge block or bailer can result in a large external pressure outside of the well. If the withdrawal is too rapid and this pressure is too great, the well casing or screen can collapse.

- A major disadvantage of well jetting is that an external supply of water is needed. The water added during well jetting may alter the hydrochemistry of the aquifer; therefore, the water added in this development procedure should be obtained from a source of known chemistry. In addition, the amount of water added during well development and the amount lost to the formation should be recorded.

- The use of air in well development can chemically alter the groundwater, either directly through chemical reaction or indirectly as a result of impurities introduced through the air stream. In addition, air entrainment within the formation can interfere with the flow of groundwater into the monitoring well. Consequently, air should not be injected in the immediate vicinity of the well screen.

FIGURE 1

SCHEMATIC DRAWING OF A SURGE BLOCK

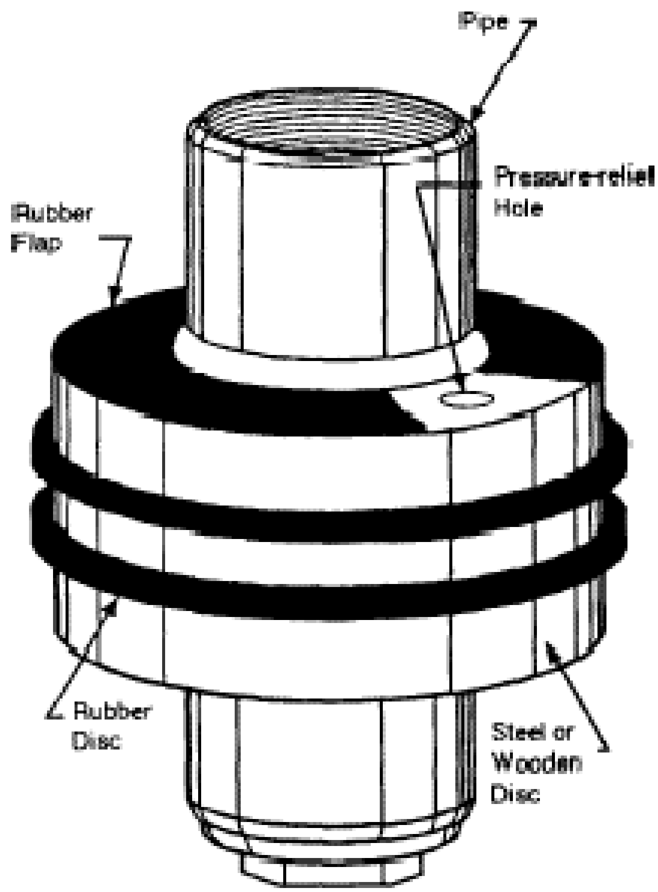

FIGURE 2

WELL DEVELOPMENT DATA SHEET

Sheet ___ of ___

WELL DEVELOPMENT DATA SHEET

BORING NO. ___________ **WELL NO.** ___________

Project ______________________
Project No. ______________________
Date(s) of Installation ______________________
Date(s) of Development ______________________
Personnel/Company ______________________
____
Type of Rig Used ______________________

Casing Diameter/Type ______________________
Borehole Diameter ______________________
Screened Interval(s) ______________________
Total Length of Well Casing ______________________
Measured Total Depth (TOC) Initial ______________
Final ______________
Initial Depth to Water
(TOC) __________ Date __________ Time __________
Stabilized Depth to Water
(TOC) __________ Date __________ Time __________

DEVELOPMENT TECHNIQUE(S) — EQUIPMENT TYPE/CAPACITY

___ Surging ______________
___ Overpumping ______________
___ Air Lift Pumping ______________
___ Backwashing ______________
___ Bailing ______________
___ Well Jetting ______________

FLUIDS ADDED

Lost Drilling Fluid: __________ Gallons
Lost Purge Water: __________ Gallons
Water During Installation: __________ Gallons
Total Fluids Added: __________ Gallons
Source of Added Water: ______________
Sample Collected of Added Water: Y N
Sample Designation of Added Water: ______________

PURGE VOLUME CALCULATION

Casing Volume: __________ Ft. of water
x __________ Gallons/Foot
= __________ Gallons per Single Casing Volume
Sand Pack Volume: __________ Ft. of Saturated Sand Pack
x __________ Gallons/Foot (borehole diameter)
= __________ Gallons (in borehole)
- __________ Gallons of Casing Volume
= __________ x 0.3 (Assuming porosity = 30%)
= __________ Gallons Within Sand Pack
Single Purge Volume: __________ Gallons (Casing Vol. + Sand Pack Vol. + Fluids Added)
Minimum Purge Volume: __________ Gallons
Actual Purge Volume: __________ Gallons
Volume Measured by: ______________
Rate of Development __________ Gallons/Minute (Hour, Day)
Pumping Rate/Depth __________ @ ______ Ft. (Below Grd.)
Immiscible Phases Present: Y N Thickness __________

Development Criteria: ______________________

Total Volume Discharged	Rate of Discharge	Time	Temp	pH	Specific* Conductance	Turbidity (NTU)	D.O., Clarity, Odor, PID Readings, Other:

Development Completed at ______________ Gallons Discharged. Date: __________ Time: __________

Personnel: ______________________
____

* Specific Conductance readings temperature compensated to 25°C, if not, report temperatures at which reading obtained.

TETRA TECH INC.
MONITORING WELL SAMPLING SHEET

Well No.: ______ Sheet ___ of ___

Personnel: ______ Day: ______ Date: ______

Casing Volume = Gallons

Initial depth to water: ft. below top of casing

[casing volume = water column height (ft) x 0.03 gal/ft (0.75-inch well) or 0.163 gal/ft (2-inch well) or 0.652 gal/ft (4-inch well)]

Organic Vapor Concentrations
Top of Casing:_______ppm Background:_______ppm

Groundwater Parameters

Time	Cumulative Volume Purged (L)	Discharge Rate (mL/min)	Depth to water (ft. below TOC)	Temperature (^oC)	Specific Conductivity (mS/cm)	Dissolved Oxygen (mg/L)	pH	ORP (mv)	Turbidity (NTU)	PID/OVM (ppm)

After sampling and, if accessible, depth to bottom: ______ ft. below TOC Purged Dry? ______

Field Measurement Equipment Used

Equipment	Model	Serial Number	Equipment	Model	Serial Number
Water Quality Meter			PID		
Turbidimeter			Filter Apparatus		
Water Level Meter			Other ______		
Pump			Other ______		

Groundwater Samples Collected (check all that apply)

Analytes of Concern

Off-Site Lab

Metals		______	
PCBs		______	
Pesticides		______	
SVOCs		______	
TPH-e		______	
TPH-p		______	
VOCs		______	
______		______	

Fate and Transport Data

Off-Site Lab

Chloride	
Alkalinity	
Ethane	
Ethene	
Hydrogen	
TDS	
TSS	

Field Test Kit Analyses

	Unfiltered	Filtered
Fe^{2+} (mg/L)		
Mn^{2+} (mg/L)		

Filter where turbidity > 50 NTU

Downhole Dissolved Oxygen

Top (mg/L)	
Middle (mg/L)	
Bottom (mg/L)	

Sample Number:______ Sample Date/Time:______

QA/QC Sample(s)? ☐ None ☐ Field Dup ☐ MS/MSD

Dup. Sample Time ______ Dup. Sample Number ______

Sample Depth (ft. below TOC): ______

Comments: ______

Method of Extraction:
☐ Submersible Pump
☐ Peristaltic Pump
☐ Disposable Bailer

Method of Sampling:
☐ Submersible Pump
☐ Peristaltic Pump
☐ Disposable Bailer

DAILY EQUIPMENT CALIBRATION LOG

NWSSBD CONCORD, CONCORD, CALIFORNIA

Date	Time	Equipment Type	Serial #	Calibration Standard Batch #	Calibration Coefficient (slope, span, etc)	Calibration Value	Calibration Reading	Successful Calibration (Y/N)	Name

Tetra Tech EM Inc.

Sheet ___ of ___

WELL DEVELOPMENT DATA SHEET

BORING NO. ____________ **WELL NO.** ____________

Project ______________________________
Project No. ______________________________
Date(s) of Installation ______________________________
Date(s) of Development ______________________________
Personnel/Company ______________________________
____
Type of Rig Used ______________________________

Casing Diameter/Type ______________________________
Borehole Diameter ______________________________
Screened Interval(s) ______________________________
Total Length of Well Casing ______________________________
Measured Total Depth (TOC) Initial ____________
Final ____________
Initial Depth to Water
(TOC) ____________ Date ____________ Time ____________
Stabilized Depth to Water
(TOC) ____________ Date ____________ Time ____________

TECHNIQUE(S) — DEVELOPMENT EQUIPMENT TYPE/CAPACITY

____ Jetting (Airlift) ______________________________
____ Surge Block ______________________________
____ Bailing ______________________________
____ Pumping ______________________________
____ Other ______________________________

FLUIDS ADDED

Lost Drilling Fluid: ____________ Gallons
Lost Purge Water: ____________ Gallons
Water During Installation: ____________ Gallons
Total Fluids Added: ____________ Gallons
Source of Added Water: ______________________________
Sample Collected of Added Water: Y N
Sample Designation of Added Water: ______________________________

PURGE VOLUME CALCULATION

Casing Volume: ____________ Ft. of water
x ____________ Gallons/Foot
= ____________ Gallons per Single Casing Volume
Sand Pack Volume: ____________ Ft. of Saturated Sand Pack
x ____________ Gallons/Foot (borehole diameter)
= ____________ Gallons (in borehole)
- ____________ Gallons of Casing Volume
= ____________ x 0.3 (Assuming porosity = 30%)
= ____________ Gallons Within Sand Pack
Single Purge Volume: ____________ Gallons (Casing Vol. + Sand Pack Vol. + Fluids Added)
Minimum Purge Volume: ____________ Gallons
Actual Purge Volume: ____________ Gallons
Volume Measured by: ______________________________
Rate of Development ________ Gallons/Minute (Hour, Day)
Pumping Rate/Depth ____________ @ ______ Ft. (Below Grd.)
Immiscible Phases Present: Y N Thickness ____________

Development Criteria: ____

Total Volume Discharged	Rate of Discharge	Time	Temp	pH	Specific* Conductance	Turbidity (NTU)	D.O., Clarity, Odor, PID Readings, Other:

Development Completed at ____________ Gallons Discharged. Date: ____________ Time: ____________

Personnel: ____

* Specific Conductance readings temperature compensated to 25°C, if not, report temperatures at which reading obtained.

TETRA TECH, INC.

DAILY TAILGATE SAFETY MEETING FORM

Date: ______________ Time: ________________ Project No.: ________________

Client: __________________________________ Site Location: __________________________

Site Activities Planned for Today: ____

____

Safety Topics Discussed
Protective clothing and equipment:
Chemical hazards:
Physical hazards:
Environmental and biohazards:
Equipment hazards:
Decontamination procedures:
Other:
Review of emergency procedures:
Employee Questions or Comments:

TETRA TECH, INC.

DAILY TAILGATE SAFETY MEETING FORM (Continued)

Attendees	
Printed Name	**Signature**

Meeting Conducted by:

_____________________________ _____________________________

Name Title

____

Signature

APPENDIX C
PROJECT-REQUIRED REPORTING LIMITS

TABLE C-1: COMPARISON OF PROJECT-REQUIRED REPORTING LIMITS AND SCREENING CRITERIA, TPH METHOD 8015, SW-846

Draft SAP, Additional Groundwater Investigation at Tidal Area Landfill, Site 1,
Naval Weapons Station Seal Beach Detachment Concord, Concord, California

Analyte	Marine Chronic AWQC[a] (µg/L)	Freshwater Chronic AWQC (µg/L)	Water PRRL[b] (µg/L)	Water PRRL Below Most Conservative AWQC?
TPH-diesel	NA	NA	2,200	NA
TPH-motor oil	NA	NA	2,200	NA
TPH-gasoline	NA	NA	1,200	NA

Notes:

a EPA. 2002d. "National Recommended Water Quality Criteria: 2002." EP-822-R-02-047. November.

b The listed PRRL reflects the maximum sensitivity of current, routinely used analytical methods. The listed PRRL will be used as the project screening criteria unless reasonable grounds are established for pursuing non-routine methods.

AWQC Ambient Water Quality Criteria
µg/L Micrograms per liter
NA Not available
PRRL Project required reporting limit

TABLE C-2: COMPARISON OF PROJECT-REQUIRED REPORTING LIMITS AND SCREENING CRITERIA, METALS METHOD 6010B, SW-846, MERCURY EPA METHOD 1631, HEXAVALENT CHROMIUM METHOD 7196A, SW-846

Draft SAP, Additional Groundwater Investigation at Tidal Area Landfill, Site 1,
Naval Weapons Station Seal Beach Detachment Concord, Concord, California

Analyte	Marine Chronic AWQC (µg/L)[1]	Freshwater Chronic AWQCa (µg/L)[1,a]	Water PRRL (µg/L)[b]	Water PRRL Below Most Conservative Screening Value?
Aluminum	NA	NA	200	NA
Antimony	NA	NA	60	NA
Arsenic	36	340	10	Yes
Barium	NA	NA	200	NA
Beryllium	NA	NA	5	NA
Cadmium	9.3	4.26	5	No[b]
Calcium	NA	NA	500	NA
Chromium	50	16	10	Yes
Cobalt	NA	NA	50	NA
Copper	NA	13.44	10	Yes
Iron	NA	NA	100	NA
Lead	8.1	64.58	3	Yes
Magnesium	NA	NA	500	NA
Manganese	NA	NA	15	NA
Mercury	0.94	52[a]	0.025	Yes
Molybdenum	NA	NA	20	NA
Nickel	NA	468	20	Yes
Potassium	NA	NA	500	NA
Selenium	71.0	NA	5	Yes
Silver	NA	3.45	5	No[b]
Sodium	NA	NA	500	NA
Thallium	NA	NA	10	NA
Vanadium	NA	NA	50	NA
Zinc	81.0	117	20	Yes
Hexavalent chromium	50	11	10	Yes

TABLE C-2: COMPARISON OF PROJECT-REQUIRED REPORTING LIMITS AND SCREENING CRITERIA, METALS METHOD 6010B, SW-846, MERCURY EPA METHOD 1631, HEXAVALENT CHROMIUM METHOD 7196A, SW-846 (Continued)

Draft SAP, Additional Groundwater Investigation at Tidal Area Landfill, Site 1,
Naval Weapons Station Seal Beach Detachment Concord, Concord, California

Notes:

a	Criterion represent acute rather than chronic AWQC. For these chemicals, chronic AWQC are not available.
b	The listed PRRL reflects the maximum sensitivity of current, routinely used analytical methods. The listed PRRL will be used as the project screening criteria unless reasonable grounds are established for pursuing non-routine methods. Cadmium and silver are not considered metals of concern for Site 1.
1	EPA. 2002d. "National Recommended Water Quality Criteria: 2002." EP-822-R-02-047. November.
µg/L	Microgram per liter
AWQC	Ambient water quality criteria
mg/kg	Milligram per kilogram
NA	Not available
PRRL	Project-required detection limit

Sources:

CFR. 2000. Title 40 *Code of Federal Regulations.* Part 131. Volume 65. Number 97. Page 31681 to 31719. May.

EPA. 2002. "National Recommended Water Quality Criteria: 2002." EP-822-R-02-047. November.

RWQCB. 1995. "San Francisco Bay Basin (Region 2) Water Quality Control Plan". June.

TABLE C-3: COMPARISON OF PROJECT-REQUIRED REPORTING LIMITS AND SCREENING CRITERIA, VOCs METHOD 8260B, SW-846
Draft SAP, Additional Groundwater Investigation at Tidal Area Landfill, Site 1,
Naval Weapons Station Seal Beach Detachment Concord, Concord, California

Compound	Marine Chronic AWQC (µg/L)[a]	Freshwater Chronic AWQC (µg/L)[a]	Water PRRL (µg/L)[b]	Water PRRL Below Most Conservative AWQC?
1,2,3-Trichloropropane	NA	NA	5	NA
Acetone	NA	NA	5	NA
Benzene	5,100[a]	5,300[a]	0.5	Yes
Bromodichloromethane	6,400	11,000[a]	0.5	Yes
Bromoform	6,400	11,000[a]	0.5	Yes
Bromomethane	6,400	11,000[a]	0.5	Yes
2-Butanone	NA	NA	5	NA
Carbon disulfide	NA	NA	0.5	NA
Carbon tetrachloride	6,400	35,200[a]	0.5	Yes
Chlorobenzene	129	250	0.5	Yes
Chloroethane	NA	NA	0.5	NA
Chloroform	6,400	1,240	0.5	Yes
Chloromethane	6,400	11,000[a]	0.5	Yes
Cis-1,3-Dichloropropene	NA	NA	0.5	NA
Dibromochloromethane	6,400	11,000[a]	0.5	Yes
1,1-Dichloroethane	NA	NA	0.5	NA
1,2-Dichloroethane	113,000[a]	20,000	0.5	Yes
1,1-Dichloroethene	NA	NA	0.5	NA
cis-1,2-Dichloroethene	NA	NA	0.5	NA
trans-1,2-Dichloroethene	NA	NA	0.5	NA
1,2-Dichloropropane	3,040	5,700	0.5	Yes
Ethylbenzene	430	32,000[a]	0.5	Yes
2-Hexanone	NA	NA	5	NA
4-Methyl-2-pentanone	NA	NA	5	NA
Methylene chloride	NA	NA	5	NA
Styrene	NA	NA	0.5	NA
1,1,2,2-Tetrachloroethane	9,020[a]	2,400	0.5	NA
Tetrachloroethene	450	NA	0.5	Yes
Toluene	5,000	17,500[a]	0.5	Yes
trans-1,3-Dichloropropene	NA	244	0.5	NA
1,1,1-Trichloroethane	31,200a	18,000[a]	0.5	Yes
1,1,2-Trichloroethane	NA	9,400	0.5	NA
Trichloroethene	NA	NA	0.5	NA
Vinyl acetate	NA	NA	0.5	NA
Vinyl chloride	NA	NA	0.5	NA
Xylene (total)	NA	NA	0.5	NA

TABLE C-3: COMPARISON OF PROJECT-REQUIRED REPORTING LIMITS AND SCREENING CRITERIA, VOCs METHOD 8260B, SW-846 (Continued)

Draft SAP, Additional Groundwater Investigation at Tidal Area Landfill, Site 1,
Naval Weapons Station Seal Beach Detachment Concord, Concord, California

Notes:

a	Criterion represent acute rather than chronic AWQC. For these chemicals, chronic AWQC are not available.
b	The listed PRRL reflects the maximum sensitivity of current, routinely used analytical methods. The listed PRRL will be used as the project screening criteria unless reasonable grounds are established for pursuing non-routine methods.

µg/L	Microgram per liter
AWQC	Ambient water quality criteria (EPA 2002d)
NA	Not available
PRRL	Project-required reporting limit

TABLE C-4: COMPARISON OF PROJECT-REQUIRED REPORTING LIMITS AND SCREENING CRITERIA, SVOCs METHOD 8270C, SW-846
Draft SAP, Additional Groundwater Investigation at Tidal Area Landfill, Site 1,
Naval Weapons Station Seal Beach Detachment Concord, Concord, California

Analyte	Marine Chronic AWQC[a] (µg/L)	Freshwater Chronic AWQC[a] (µg/L)	Water PRRL[b] (µg/L)	Water PRRL Below Most Conservative AWQC?
1,4-Dioxane	NA	NA	NA	NA
Acenaphthene	710	520[a]	10	Yes
Acenaphthylene	300[a]	NA	10	Yes
Anthracene	300[a]	NA	10	Yes
Benzo(a)anthracene	300[a]	NA	10	Yes
Benzo(a)pyrene	300[a]	NA	10	Yes
Benzo(b)fluoranthene	300[a]	NA	10	Yes
Benzo(g,h,i)perylene	300[a]	NA	10	Yes
Benzo(k)fluoranthene	300[a]	NA	10	Yes
Bis(2-chloroethoxy)methane	NA	NA	10	NA
Bis(2-chloroethyl)ether	NA	122	10	NA
Bis(2-chloroisopropyl)ether	NA	122	10	NA
Bis(2-ethylhexyl)phthalate	NA	NA	10	NA
4-Bromophenyl-phenylether	NA	122	10	NA
Butylbenzylphthalate	2,944[a]	3	10	No[b]
Carbazole	NA	NA	10	NA
4-Chloro-3-methylphenol	NA	NA	10	NA
4-Chloroaniline	NA	NA	10	NA
2-Chloronaphthalene	7.5[a]	1,600[a]	10	No[a,b]
2-Chlorophenol	NA	2,000[a]	10	Yes
4-Chlorophenyl-phenylether	NA	NA	10	NA
Chrysene	300[a]	NA	10	Yes
Dibenz(a,h)anthracene	300[a]	NA	10	Yes
Dibenzofuran	NA	NA	10	NA
1,2-Dichlorobenzene	129	763	10	Yes
1,3-Dichlorobenzene	129	763	10	Yes
1,4-Dichlorobenzene	129	763	10	Yes
3,3'-Dichlorobenzidine	NA	NA	30	NA
2,4-Dichlorophenol	NA	365	10	NA
Diethylphthalate	2,944[a]	3	10	NA
2,4-Dimethylphenol	NA	2,120[a]	10	NA
Dimethylphthalate	2,944[a]	3	10	No[b]
Di-n-butylphthalate	NA	NA	10[a]	NA
4,6-Dinitro-2-methylphenol	NA	NA	50	NA
2,4-Dinitrophenol	4,850[a]	150[a]	50	Yes

TABLE C-4: COMPARISON OF PROJECT-REQUIRED REPORTING LIMITS AND SCREENING CRITERIA, SVOCs METHOD 8270C, SW-846 (Continued)
Draft SAP, Additional Groundwater Investigation at Tidal Area Landfill, Site 1,
Naval Weapons Station Seal Beach Detachment Concord, Concord, California

Analyte	Marine Chronic AWQC[a] (µg/L)	Freshwater Chronic AWQC[a] (µg/L)	Water PRRL[b] (µg/L)	Water PRRL Below Most Conservative AWQC?
2,4-Dinitrotoluene	590[a]	230[a]	10	Yes
2,6-Dinitrotoluene	590[a]	230	10	Yes
Di-n-octylphthalate	2,944[a]	3	10	No[b]
Fluoranthene	16	3,980[a]	10	Yes
Fluorene	300[a]	NA	10	Yes
Hexachlorobenzene	129	50[a]	10	Yes
Hexachlorobutadiene	32[a]	9.3	10	No[b]
Hexachlorocyclopentadiene	7.0[a]	5.2	10	No[b]
Hexachloroethane	940[a]	540	10	Yes
Indeno(1,2,3-cd)pyrene	300[a]	NA	10	Yes
Isophorone	12,900[a]	117,000	10	Yes
2-Methylnaphthalene	NA	NA	10	NA
2-Methylphenol	NA	NA	10	NA
4-Methylphenol	NA	NA	10	NA
Naphthalene	2,350[a]	620	10	Yes
2-Nitroaniline	NA	NA	50	NA
4-Nitroaniline	NA	NA	30	NA
3-Nitroaniline	NA	NA	50	NA
Nitrobenzene	6,680[a]	27,000[a]	10	Yes
2-Nitrophenol	4,850[a]	150[a]	10	Yes
4-Nitrophenol	4,850[a]	150[a]	10	Yes
n-Nitroso-di-n-propylamine	3,300,000[a]	5,850[a]	10	Yes
n-Nitrosodimethylamine	NA	NA	10	NA
n-Nitrosodiphenylamine	3,300,000[a]	5,850[a]	10	Yes
2,2'-Oxybis(1-chloropropane)	NA	NA	10	NA
Pentachlorophenol	7.9	15	50	NA
Phenanthrene	300	NA	10	Yes
Phenol	5,800[a]	2560	10	Yes
Pyrene	300[a]	NA	10	Yes
1,2,4-Trichlorobenzene	129	50	10	NA
2,4,5-Trichlorophenol	NA	NA	50	NA
2,4,6-Trichlorophenol	NA	970	10	NA

TABLE C-4: COMPARISON OF PROJECT-REQUIRED REPORTING LIMITS AND SCREENING CRITERIA, SVOCs METHOD 8270C, SW-846 (Continued)

Draft SAP, Additional Groundwater Investigation at Tidal Area Landfill, Site 1,
Naval Weapons Station Seal Beach Detachment Concord, Concord, California

Notes:

a	Criterion represent acute rather than chronic AWQC. For these chemicals, chronic AWQC are not available.
b	The listed PRRL reflects the maximum sensitivity of current, routinely used analytical methods. The listed PRRL will be used as the project screening criteria unless reasonable grounds are established for pursuing non-routine methods. The analytes with PRRLs that exceed screening criteria are not considered chemicals of concern for Site 1.
AWQC	Ambient water quality criteria (EPA 2002d)
µg/L	Micrograms per liter
NA	Not available
PRRL	Project-required reporting limit

TABLE C-5: COMPARISON OF PROJECT-REQUIRED REPORTING LIMITS AND SCREENING CRITERIA, PESTICIDES METHOD 8081A, SW-846

Draft SAP, Additional Groundwater Investigation at Tidal Area Landfill, Site 1,
Naval Weapons Station Seal Beach Detachment Concord, Concord, California

Analyte	Marine Chronic AWQC[a,1] (µg/L)	Freshwater Chronic AWQC[a,1] (µg/L)	Water PRRL[b] (µg/L)	Water MDL[c] (µg/L)	Water PRRL Below Most Conservative AWQC?
Alpha-BHC	NA	NA	0.05	0.0004	NA
Gamma-BHC (Lindane)	0.16[a]	0.95[a]	0.05	0.0011	Yes
Aldrin	1.3[a]	3.0[a]	0.05	0.0011	Yes
Chlordane	0.004	0.0043	0.05	0.039	No[b]
4,4'-DDD	NA	NA	0.1	0.0004	NA
4,4'-DDE	NA	NA	0.1	0.015	NA
4,4'-DDT	0.001	0.001	0.1	0.025	No[b]
Dieldrin	0.0019	0.056	0.1	0.0007	No[b]
Endrin	0.0023	0.036	0.1	0.0007	No[b]
Heptachlor	0.0036	0.0038	0.1	0.001	No[b]
Heptachlor epoxide	0.0036	0.0038	0.1	0.0027	No[b]
Methoxychlor	0.03	0.03	0.5	0.0012	No[b]
Toxaphene	NA	NA	5.0	0.13	NA

Notes:

a Criterion represent acute rather than chronic AWQC. For these chemicals, chronic AWQC are not available.

b The listed PRRL reflects the maximum sensitivity of current, routinely used analytical methods. The listed PRRL will be used as the project screening criteria unless reasonable grounds are established for pursuing non-routine methods.

c The minimum concentration that can be measured and reported with 99% confidence that the analyte concentration is greater than zero and is determined from analysis of a sample in a given matrix type containing the analyte.

1 EPA. 2002d. “National Recommended Water Quality Criteria: 2002.” EP-822-R-02-047. November.

AWQC Ambient Water Quality Criteria
MDL Method detection limit
µg/L Micrograms per liter
NA Not available
PRRL Project required reporting limit

TABLE C-6: COMPARISON OF PROJECT-REQUIRED REPORTING LIMITS AND SCREENING CRITERIA, EXPLOSIVES METHOD 8330, SW-846 8330

Draft SAP, Additional Groundwater Investigation at Tidal Area Landfill, Site 1,
Naval Weapons Station Seal Beach Detachment Concord, Concord, California

Analyte	Marine Chronic AWQC[1] (µg/L)	Freshwater Chronic AWQC[1] (µg/L)	Water PRRL (µg/L)	Water PRRL Below Screening Criteria?
1,2,3-Propanetriol	NA	NA	10	Yes
1,3-Dinitrobenzene	NA	NA	10	Yes
1,3,5-Trinitrobenzene	NA	NA	10	Yes
2,4,6-Trinitrotoluene	NA	NA	10	Yes
2,4-Dinitrotoluene	NA	230	10	Yes
2,4-Diamino-6-nitrotoluene	NA	NA	10	Yes
2,6-Diamino-4-nitrotoluene	NA	NA	10	Yes
2,6-Dinitrotoluene	NA	230	10	Yes
2-Amino-4,6-dinitrotoluene	NA	NA	10	Yes
2-Nitrotoluene	NA	NA	10	Yes
2/4-Nitrotoluene	NA	NA	10	Yes
3-Nitrotoluene	NA	NA	10	Yes
4-Amino-2,6-dinitrotoluene	NA	NA	10	Yes
4-Nitrotoluene	NA	NA	10	Yes
Benzene, 1-methyl-3-nitromethyl-3-nitro-	NA	NA	10	Yes
HMX	NA	NA	10	Yes
Nitrobenzene	NA	NA	10	Yes
Nitroglycerin	NA	NA	10	Yes
Nitrotoluene	NA	NA	10	Yes
o-Nitrotoluene	NA	NA	10	Yes
RDX (Cyclonite)	NA	NA	10	Yes
Tetryl	NA	NA	10	Yes
Trinitrobenzene	NA	NA	10	Yes

Note:

1 EPA. 2002d. “National Recommended Water Quality Criteria: 2002.” EP-822-R-02-047. November.

TABLE C-7: COMPARISON OF PROJECT-REQUIRED REPORTING LIMITS AND SCREENING CRITERIA, PERCHLORATE

Draft SAP, Additional Groundwater Investigation at Tidal Area Landfill, Site 1,
Naval Weapons Station Seal Beach Detachment Concord, Concord, California

Analyte	Screening Criteria (μg/L)	California Public Health Goal (μg/L)	Water PRRL (μg/L)	Water PRRL Below Screening Criteria?
Perchlorate (EPA 314.0)	1.0[a]	6.0[b]	2.0	No[c]
Perchlorate (LC/MS/MS)	1.0[a]	6.0[b]	0.20	Yes[c]

Notes:

a Based on EPA draft reference dose for perchlorate presented in “Perchlorate Environmental Contamination: Toxicological Review and Risk Characterization (2002 External Review Draft)” (EPA 2002a).

b The California Office of Environmental Health Hazards Assessment (OEHHA) recently established a Public Health Goal (PHG) of 6 μg/L for perchlorate in drinking water (OEHHA 2004).

c All samples will be analyzed using both EPA method 314.0 and the LC/MS/MS method.

μg/L Micrograms per liter

TABLE C-8: COMPARISON OF PROJECT-REQUIRED REPORTING LIMITS AND SCREENING CRITERIA, MISCELLANEOUS ANALYTES

Draft SAP, Additional Groundwater Investigation at Tidal Area Landfill, Site 1,
Naval Weapons Station Seal Beach Detachment Concord, Concord, California

Miscellaneous Analytes	Groundwater Screening Criteria (mg/L)	Water PRRL (mg/L)	Water PRRL Below Screening Criteria?
Total dissolved solids	NA	10	NA
Total suspended solids	NA	4	NA
General anions	NA	0.5	NA

Notes:

EPA U.S. Environmental Protection Agency

mg/L Milligrams per liter

PRRL Project-required reporting limit

APPENDIX D
APPROVED NAVY LABORATORIES

TABLE D-1: TETRA TECH EM INC.–APPROVED NAVY LABORATORIES UNDER BASIC ORDERING AGREEMENT

Draft SAP, Additional Groundwater Investigation at Tidal Area Landfill, Site 1,
Naval Weapons Station Seal Beach Detachment Concord, Concord, California

Analytical Group	
Lab Address:	12189 Pennsylvania Street Thornton, CO 80241
Point of Contact:	Joe Egry / Mary Fealey
Phone:	(800) 873-8707 X103/X135
Fax:	(303) 469-5254
Business Size:	SWO
E-mail:	mfealey@analyticagroup.com

Applied Physics and Chemistry Laboratory	
Lab Address:	13760 Magnolia Avenue Chino, CA 91710
Point of Contact:	Dan Dischner / Eric Wendland
Phone:	(909) 590-1828 X203/X104
Fax:	(909) 590-1498
Business Size:	SDB
E-mail:	marketing@apclab.com

Columbia Analytical Services	
Lab Address:	5090 Caterpillar Road Redding, CA 96003
Point of Contact:	Karen Sellers / Howard Boorse
Phone:	(530) 244-5262 / (360) 577-7222
Fax:	(530) 244-4109
Business Size:	LB
E-mail:	lkennedy@kelso.caslab.com

Curtis and Tompkins, Ltd	
Lab Address:	2323 Fifth Street Berkeley, CA 94710
Point of Contact:	Anna Pajarillo / Mike Pearl
Phone:	(510) 486-0925 X103/ X108
Fax:	(510) 486-0532
Business Size:	SB
E-mail:	mikep@ctberk.com

EMAX Laboratories Inc.	
Lab Address:	1835 205th Street Torrance, CA 90501
Point of Contact:	Ye Myint / Jim Carter
Phone:	(310) 618-8889 X121/X105
Fax:	(310) 618-0818
Business Size:	SDB/WO
E-mail:	ymyint@emaxlabs.com

Laucks Laboratories	
Lab Address:	940 S. Harney Street Seattle, WA 98108
Point of Contact:	Mike Owens / Kathy Kreps
Phone:	(206) 767-5060
Fax:	(206) 767-5063
Business Size:	SB
E-mail:	KathyK@laucksIabs.com

Sequoia Analytical	
Lab Address:	1455 McDowell Blvd. North, Suite D Petaluma, CA 94954
Point of Contact:	Michelle Wiita
Phone:	(707) 792-7517
Fax:	(707) 792-0342
Business Size:	LB
E-mail:	

Notes:

LB	Large business
SB	Small business
SDB	Small disabled business
SWO	Small woman-owned
WO	Woman-owned